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KINGS BAY UPPER BASIN REMEDIAL MEASURES

Physical Model Study

by

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and

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Kings Bay, Georgia 31547

HYDRAULICS LABORATORY

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A hybrid modeling system (coupled physical and numerical models) was developed to investigate the hydrodynamic and sedimentation processes of Cumberland Sound and the interior Kings Bay navigation channel. This report presents the results of physical model tests conducted to evaluate the effects of nine remedial measure plans on hydrodynamic conditions. These model data were also used to provide average boundary forcing conditions for the numerical model study conducted to determine the impact of the various plans on sedimentation in the Kings Bay basin and adjacent navigation channels.

Generally, each of the nine plans had very little impact on base conditions downstream from Kings Bay. However, tidal heights and currents in Kings Bay and the immediate area were altered considerably by each plan investigated. Tests to determine the impact of the various plans on base condition salinities were not conducted during this study.

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19. ABSTRACT (Continued).

A study was conducted to determine the repeatability of tidal heights and current velocities in the physical model. The results of a statistical analysis of middepth current velocity data from 12 locations throughout the estuary are included in this report.

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PREFACE

The modeling study reported herein was requested by the Department of the Navy. Officer in Charge of Construction (OICC), Kings Bay, in a letter to the US Army Engineer Waterways Experiment Station (WES) dated 16 September 1982. WES was requested to undertake a modeling study to examine the hydrodynamics and sedimentation processes of the Kings Bay Submarine Base harbor facilities and channels, to predict long-term average maintenance dredging requirements for planning channel enlargements, and to evaluate possible remedial measures. A two-part study was developed. Part one, referred to as Model A, was a hybrid model (coupled physical and numerical models) designed to address the interior portion of the system, inland of the throat of St. Marys inlet. The second part, Model B,* addressed the outer portion seaward of the inlet throat. This report is part of the Model A study and describes the remedial measures physical model study. Other reports** describe the hybrid modeling system in detail and address the physical and the numerical model verifications and numerical model evaluations of remedial measures.

This study was conducted in the Hydraulics Laboratory of WES under the general supervision of Messrs H. B. Simmons and F. A. Herrmann, Jr., former and present Chiefs of the Hydraulics Laboratory, respectively; R. A. Sager, Assistant Chief of the Hydraulics Laboratory; W. H. McAnally, Chief of the Estuaries Division; R. A. Boland and J. V. Letter, former and present Chiefs of the Estuarine Simulation Branch, Estuaries Division; and M. A. Granat, Estuarine Engineering Branch, Estuaries Division, Project Manager. Mr. N. J. Brogdon, Jr., Estuarine Simulation Branch, was Project Engineer for the physical model and Mr. Granat was Project Engineer for the numerical models. Physical model technicians who assisted throughout the investigation included

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* S. Rao Vemulakonda, Norman W. Scheffner, Jeffrey A. Earickson, and Lucia W. Chou. 1988 (Apr). "Kings Bay Coastal Processes Numerical Model," Technical Report CERC-88-3, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

** Mitchell A. Granat, Noble J. Brogdon, John T. Cartwright, and William H. McAnally Jr. 1989 (Jul). "Verification of the Hydrodynamic and Sediment Transport Hybrid Modeling System for Cumberland Sound and Kings Bay Navigation Channel. Georgia," Technical Report HL-89-14, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

J. S. Ashley, J. T. Cartwright, C. R. Holmes, and D. M. White, all of the Estuarine Simulation Branch.

This report was prepared by Mr. Brogdon with the assistance of Messrs Letter, Granat, and McAnally.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENTS

Non-SI units of measurements used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3084	metres
miles (US statute)	1.609344	kilometres
square feet	0.09290304	square metres
square miles (US statute)	2.589988	square kilometres

KINGS BAY UPPER BASIN REMEDIAL MEASURES

Physical Model Study

PART I: INTRODUCTION

Background

1. Ownership of the Kings Bay Facility, located adjacent to Cumberland Sound in Southeast Georgia, was transferred from the Department of the Army to the Department of Navy in July 1978 for development of a naval submarine base for Poseidon class submarines. Extensive modifications to Kings Bay, adjacent areas, and connecting channels were initiated in 1978 to adapt Kings Bay to a Poseidon class submarine base. These modifications, etc. are described in the verification report.* The Model B report** describes modifications to the St. Marys inlet and offshore ocean entrance channel.

2. A hybrid modeling system (coupled physical and numerical models) was developed to investigate the effects of Kings Bay and channel modifications on hydrodynamics and sedimentation within the study area. This same approach (hybrid modeling) was used to evaluate potential remedial measures. This report presents the results of the physical model study conducted to determine effects of 9 remedial measure plans on hydrodynamic conditions. A subsequent numerical model report will address the effects of various remedial plans on sedimentation.

Objectives

3. The primary objectives of the modeling study were to predict average

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* Mitchell A. Granat, Noble J. Brogdon, John T. Cartwright, and William H. McAnally, Jr. 1989 (Jul). "Verification of the Hydrodynamic and Sediment Transport Hybrid Modeling System for Cumberland Sound and Kings Bay Navigation Channel, Georgia," Technical Report HL-89-14, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

** S. Rao Vemulakonda, Norman W. Scheffner, Jeffrey A. Earickson, and Lucia W. Chou. 1988 (Apr). "Kings Bay Coastal Processes Numerical Model," Technical Report CERC-88-3, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

currents and long-term average maintenance dredging requirements for enlarged channel and port facilities for the submarine base, to develop and evaluate remedial measures that might reduce sedimentation without adversely affecting ship handling, and to enhance base operational readiness. Another primary goal of the entire study effort was to maintain a fast-track pace to provide the Navy with results on priority tasks while maintaining the required flexibility to adapt to project design changes. Model results were provided to the Navy in memorandum format as they became available.

4. The objective of the model tests described here was to collect hydrodynamic data to be used to: (a) evaluate the hydrodynamic impacts and (b) supply boundary conditions for the numerical modeling effort on the shoaling rate impacts in Kings Bay and navigation channel of various channel design plans.

Scope

5. This report describes the tests and results of the physical model remedial measure study. Nine plans were investigated during the course of the study.

Model

6. The Kings Bay model reproduces approximately 206 square miles of the prototype area including about 14 miles of the St. Marys River (7 miles upstream from St. Mary); the Jolly River: about 6 miles of the Amelia River; all of Cumberland Sound, and Kings Bay area; about 13 miles of the Crooked River upstream to Sheffield Island, and about 9 miles of the Cumberland Dividings and River to Terrapin Point; the system of sloughs, creeks and rivers that effect tidal action throughout the model area; about 220 square miles of the Atlantic Ocean from about 5 miles south and 14 miles north of the respective St. Marys Inlet jetties. The ocean area was reproduced to well beyond the 45 ft contour, about 4 miles seaward of the jetties; the remaining ocean area, ocean boundary, was molded at a flat 100 ft elevation. Propagation of tidal flow through the St. Andrews system was simulated with an artificial labyrinth system opening to the model ocean. The model limits of the area reproduced are shown in Figure 1.

7. The model was constructed to linear length scale ratio, model to prototype of 1:100 vertically and 1:1000 horizontally. From the basic length ratios the following relations were computed by the Froudian relations:

Characteristic	Ratio
Slope	10:1
Velocity	1:10
Time	1:100
Discharge	1:1,000,000
Volume	1:100,000,000
Area (cross-section)	1:100,000
Area (horizontal)	1:1,000,000

The salinity ratio for the study was 1:1: One prototype cycle (semidiurnal) of 12 hr 25 min was reproduced in the model in 7.452 min. Horizontal grid coordinates are based on the GA. coordinate system, and vertical control was based on local mean low water (mlw) datum. The model was approximately 126 ft long and 108 ft wide and covered an area of about 12,600 sq ft. It was completely inclosed to protect it and its appurtenances from the weather, and to permit uninterrupted operation.

8. A description of the model and appurtenances, and details of model adjustment, verification, limitation, and accuracy are presented in Granat et al.*

* Op. cit.

PART II: MODEL TEST CONDITIONS

9. All physical model tests reported herein were conducted with the model operating with a 5.7 ft tide (ocean), a source salinity concentration of 32.5 ppt, and a total freshwater inflow of 1,100 cfs. The St. Marys River and Crooked River freshwater inflows were 1,000 cfs and 100 cfs, respectively.

10. The location of stations monitored for each test condition are shown in Figure 1. Current velocity and direction data were collected at 35 locations throughout the model, and water surface elevation data at 10 locations. The data presented herein represents the average of at least 3 repeated measurements. Current velocities and water surface elevation data were monitored over a period of 3 tidal cycles and averaged. No salinity data were obtained during this phase of the testing program.

11. The basic channel conditions are shown in Figure 2. The entrance channel was 500 ft wide and had a total depth of 49 ft mlw. The interior navigation channel from Fort Clinch to Kings Bay entrance had a minimum width of 500 ft and a depth of 46 ft mlw. Kings Bay and Upper Turning Basin had a depth of 49 ft mlw. The Magnetic Silencing Facility (MSF) area had a depth of 46 ft mlw. The Poseidon Floating dry dock and tender area (PSDN/ARDM) was at a depth of 41 ft mlw, and the Small Boat Basin had a depth of 21 ft mlw. The Atlantic Intracoastal Waterway Realignment route C was molded in to a depth of 12 ft mlw.

PART III: DESCRIPTION OF PLANS

P4-Z

12. Plan P4-Z was the basic plan condition requested by OICC in August 1985 (herein referred to as base) and consisted of the above described channel conditions. All plan test data (P4-2 through P4-10) reported herein was compared to Plan P4-Z data to determine effects. Plan P4-Z was not Pre-Trident conditions nor existing conditions.

P4-2

13. Plan P4-2 consisted of base condition channel dimensions and depths plus upper Kings Bay closed off from Marianna Creek and Crooked River with a tide barrier structure extending from the northern end of the dry dock to the northern end of Crab Island (Figure 2).

P4-3

14. Plan P4-3 consisted of the base condition channel dimensions and depths, plus the tide barrier as described for Plan P4-2; however, a 400-ft-wide tide gate was installed near the center of the barrier (Figure 2). Model tests were conducted with the tide gate closed during the flood phase of the tide cycle (hr 3 through 10) and open during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

P4-4

15. Plan P4-4 was the same as Plan P4-3, except for the barrier gate operation, which was reversed. The tide gate was open during the flood phase of the tide cycle (hr 3 through 10), and closed during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

P4-5

16. Plan P4-5 consisted of base condition channel dimensions and depths

with the addition of a dredged channel extending from upper Kings Bay through the small stream connecting the upper basin to the South Fork of the Crooked River (Figure 2). The connecting channel had a width of 400 ft and a depth of 16 ft mlw. There was no tidal barrier.

P4-6

17. Plan P4-6 was similar to Plan P4-5, except that a tide barrier was installed with a gate located approximately half-way between the northern end of the dry dock and Crab Island (Figure 2). Model tests were conducted with the tide gate closed during the flood phase of the tide cycle (hr 3 through 10), and open during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

P4-7

18. Plan P4-7 was similar to Plan P4-6, except that the tide gate operation was reversed. Model tests were conducted with the tide gate open during the flood phase of the tide cycle (hr 3 through 10) and closed during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

P4-8

19. Plan P4-8 consisted of base condition channel dimensions and depths with the addition of a 400 ft wide by 16 ft deep channel extending from upper Kings Bay northwest through Marianna Creek to Crooked River just downstream from the Crooked River State Park (Figure 2). There was no tidal barrier.

P4-9

20. Plan P4-9 was similar to Plan P4-8, except for the addition of a gated tide barrier connecting the northern end of the dry dock to the northern end of Crab Island. Model tests were conducted with the tide gate closed during the flood phase of the tide cycle (hr 3 through 10) and open during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

P4-10

21. Plan P4-10 was identical to Plan P4-9, except the operation of the tide gate was reversed. Model tests were conducted with the tide gate open during the flood phase of the tide cycle (hr 3 through 10) and closed during the ebb phase of the tide cycle (hr 0 through 3 and hr 10 through 12.42).

PART IV: TEST RESULTS

22. The physical model test results for each of the 9 plans tested are compared to the base Test results (Plan P4-Z). The test results are presented in three basic data groups; (a) Plans P4-2, P4-3, and P4-4 - base channel dimensions plus barriers, (b) Plans P4-5, P4-6, and P4-7 - Kings Bay to Crooked River South Fork connecting channel installed, (c) Plans P4-8, P4-9, and P4-10 - Kings Bay to Crooked River (Crooked River State Park) connecting channel installed.

23. The effects of Plans P4-2, P4-3, and P4-4 on hourly water surface elevations throughout a tidal cycle are presented in Plates 1 to 4, and the effects on hourly current velocities in Plates 5 to 39. The effects of the plans at selected locations, presented as channel profiles of flow predominance and maximum current velocities, are shown in Figures 3 to 5, and Figures 6 to 8, respectively.

24. The effects of Plans P4-5, P4-6, and P4-7 on hourly water surface elevations and hourly current velocities throughout a complete tidal cycle are presented in Plates 40 to 43, and 44 to 78, respectively. The effects of Plans P4-5, P4-6, and P4-7 on flow predominance and maximum current velocities are shown in Figure 9 to 11, and 12 to 14, respectively.

25. The effects of Plans P4-8, P4-9, and P4-10 on hourly water surface elevations and hourly current velocities throughout a complete tidal cycle are shown in Plates 79 to 82, and Plates 83 to 117, respectively. Effects of above plans on flow predominance and maximum current velocities are shown in Figures 15 to 17 and 18 to 20, respectively.

26. Current velocity data for base and all plan tests were analyzed to determine flow predominance. This method of presenting current velocity data reduces magnitude, direction, and duration of the currents to a single expression that defines the predominant direction and percentage of total flow at any given point. This expression was derived from a conventional plot of velocity versus time at any given point. The areas subtended by both ebb and flood portions of the curve were measured and summarized. The area subtended by the flood portion of the curve was then divided by the total area to determine what percentage of the total flow was in the flood direction. For simplification, only the percent of flow in the flood direction was calculated, then a value of 50 percent was subtracted from each calculation to determine

predominant direction and magnitude. A negative (-) sign and a positive (+) sign were designated to indicate predominant ebb and flood directions, respectively. Using this method of analysis, a value of 0 percent indicates that flow in both the ebb and flood directions is equally balanced; the ebb and flood portion of the velocity curve are equal. A value of +50 percent indicates that flow at that point is in the flood direction at all times during a tidal cycle, while a -50 percent value indicates flow in the ebb direction throughout a tidal cycle. The figures in this report use the above method to show flow predominance.

PART V: DISCUSSION OF TEST RESULTS

27. No effort will be made to discuss the effects of the various plans at each individual data collection station. The analysis will concentrate on data collected at stations located along the navigation channel centerline and into and through Kings Bay proper. Major emphasis will be placed on effects to water surface elevations, flow predominance, and maximum current velocities. Current velocity data for base and all plan tests were analyzed to determine flow predominance.

Plan P4-2

28. Effects to water surface elevations at most stations throughout the estuary were generally within the limits of model repeatability (see Part VI). The plan resulted in lowering the water surface plane about 0.1 ft at stations 6 and 7, both located south of the proposed tide barrier. The maximum effect to water surface elevations was observed at station 10, located north of Kings Bay and proposed barrier. Plan P4-2 at station 10 resulted in low-water and high-water increases of 0.7 ft and 0.3 ft, respectively. This resulted in a tidal range reduction of 0.4 ft.

29. Effects of plan P4-2 on flow predominance values are shown in Figures 3-5. These data show that plan P4-2 had very little effect on flow predominance values in the navigation channel from the estuary entrance upstream to about station 1385 (Drum Point Island). However, stations located upstream from Drum Point Island and continuing into Kings Bay were influenced by the installation of the Plan. Flow predominance values at the surface resulted in further weakening existing weak ebb flow predominance values. Flow predominance values at both middepth and bottom were generally changed from the flood direction to the ebb direction, opposite the effect observed at the surface. Overall the plan resulted in increased flow predominance in the ebb direction through Kings Bay.

30. Maximum current velocities (Figures 6-8) along the navigation channel were influenced very little downstream from Drum Point Island. Maximum current velocities at the surface, both ebb and flood, were reduced from about 1.0 fps - 1.5 fps to less than 0.5 fps from Kings Bay entrance (Station 1182) to the upper end of Kings Bay (Station 2089) with the plan installed.

Middepth and bottom maximum current velocities were likewise reduced from an average velocity of about 0.8 fps to less than 0.2 fps with the plan installed. Maximum ebb current velocity at station 1014 (located upstream of the closure in Marianna Creek) was reduced from 3.3 fps to 0.8 fps. The maximum flood velocity was reduced from 1.8 fps to 0.8 fps with the plan installed.

Plan P4-3

31. The effects of Plan P4-3 on water surface elevations are shown in Plates 1-4. Very little change in water surface elevations were observed at stations 1, 2, and 3. Stations 4-9 showed a slight reduction in the water surface plane with the plan installed. Low-water elevation at station 10 was raised 0.4 ft and high-water elevation was lowered 0.3 ft, resulting in a range reduction at this station of 0.7 ft. Both low-and-high water occurred about 1 hr later than observed during base test.

32. The effects of Plan P4-3 on flow predominance are shown in Figures 3-5. Flow predominance values at stations located along the navigation channel from the estuary entrance to Kings Bay entrance (Station 1182) changed very little with the plan installed. The small changes observed in this reach of the channel were generally in the direction of increased ebb flow. The largest changes occurred in Kings Bay where large increases in flow predominance in the ebb direction was observed, as expected, since the tide gate was closed during flood and opened during ebb tide. An exception to this was observed at station 1142 (middepth and bottom), where the increase in the flow predominance was toward a stronger flood flow. However, flow predominance values at this station should be used with extreme caution since the velocities were extremely low, particularly at middepth and bottom, for both base and plan conditions. Very small changes in velocity magnitude can sometimes be reflected as large changes in the flow predominance calculations at locations where current velocities are low in magnitude.

33. Effects on maximum current velocities are shown in Figures 6-9. Maximum current velocities along the navigation channel from the estuary entrance to Kings Bay entrance were influenced very little by the plan. Generally, both maximum ebb and flood current velocities were decreased inside Kings Bay as a result of the plan.

Plan P4-4

34. The effects of Plan P4-4 on water surface elevations are shown in Plates 1-4. The largest effects occurred at stations 6, 7 and 10, each located in Kings Bay or immediate vicinity. The water surface plane was lowered about 0.1 ft at station 6, and the phase at station 7 was about 15 min earlier than base. The range at station 10 was decreased about 0.4 ft; low-water occurred about 45 min later, and high-water about 15-30 min later than base conditions.

35. The effects of Plan P4-4 on flow predominance values are shown in Figures 3-5. Flow predominance values, like those observed with Plans P4-2 and P4-3, were changed very little from the estuary entrance up to Kings Bay entrance. As expected, with the tide gate open during flood tide and closed during ebb tide, the flow predominance values were increased in the flood direction throughout Kings Bay (sta 1851-2089).

36. Maximum current velocities are shown in Figures 6-8. These data show that Plan P4-4 had a minimum impact on maximum current velocities in the navigation channel south of Kings Bay entrance. Inside Kings Bay base condition maximum current velocities, both in the ebb and flood direction, were reduced from about 1.0-1.5 fps to less than 0.3 fps when the plan was installed.

Plan P4-5

37. The effects of Plan P4-5 on water surface elevations are shown in Plates 40-43. Water surface elevations throughout the estuary were changed very little by the plan. Maximum changes occurred at stations located in the immediate Kings Bay area. Station 6 data showed that the water surface plane at this point was lowered about 0.1 ft; station 7 data showed that high-water elevation was 0.1 ft higher than base; and station 10 data showed that low-water was about 0.2 ft higher than base conditions.

38. Figures 9-11 show the effects of the plan on flow predominance. The effects of the plan on flow predominance along the navigation channel from the estuary entrance up to Kings Bay entrance were minimum (very small overall increase toward stronger flood flow). No directional change was observed at the surface or middepth along the entire profile length. A change in

direction at the bottom was noted at stations 2074 and 2089, each located in the upper end of Kings Bay. The base condition flow predominance value at station 2074 (bottom) was in the ebb direction by about 5 percent (weak ebb). The plan changed this to a strong flood flow value of 33 percent. The flow predominance value at station 2089 (bottom) was changed from a strong flood value (35 percent) to a fairly strong ebb value of 16 percent. Again, caution should be observed in using these flow predominance values since current velocities at this location were generally very low throughout the tidal cycle. At station 1066 (middepth) the plan resulted in decreasing a strong ebb flow (36 percent) to a value of about 2 percent.

39. Maximum current velocities along the navigation channel centerline (Figures 12-14) were influenced very little by the plan. Again, as observed with flow predominance values, the largest changes took place in Kings Bay and immediate vicinity. Even with large changes occurring to both flow predominance values and maximum current velocities in upper Kings Bay, they are not expected to impose any problem to navigation as in each case (station 2074 and 2089) maximum currents were generally about 1.0-2.0 fps. In general, Plan P4-5 would have very little effect on current velocities in Kings Bay or entrance channel. Maximum current velocities at station 1066 were increased during flood flow and decreased during ebb flow.

Plan P4-6

40. The effects of Plan P4-6 on water surface elevations are shown in Plates 40-43. The largest change occurred at stations located in Kings Bay and immediate vicinity of the closure. Station 6, located at Kings Bay entrance, had very little change to high-or-low water elevations, but did experience a slight phase shift during the flood phase of the tide. The plane was lowered about 0.2 ft at station 7, but no phase shift was observed. The greatest effect of the closure structure was noted at station 10, located upstream from the structure. The water surface plane at this station was raised about 0.3 ft and the phase of tide was shifted about 30 min later.

41. The effects of Plan P4-6 on flow predominance values are shown in Figures 9-11. Very little change was noted in the navigation channel downstream from Kings Bay. Changes were observed in Kings Bay and immediate area. With the exception of the surface depth, a weak flood predominance existed at

all stations within Kings Bay during base conditions. With Plan P4-6 installed these values were changed to strong ebb flow values. Data collected at all depths at station 1142 showed that currents were almost always in the ebb direction. Flow predominance values along the entire navigation channel were changed toward a slightly stronger ebb.

42. Effects of Plan P4-6 on maximum ebb and flood current velocities are shown in Figures 12-14. These data show that the plan changed maximum current velocities very little at stations located along the navigation channel and downstream from Kings Bay. Maximum flood current velocities were generally reduced to less than 0.2 fps at all depths at stations located in Kings Bay. Maximum ebb current velocities at the surface were generally slightly higher than those observed during base conditions. Maximum ebb current velocity at station 2089 was increased from 1.7 fps to 3.8 fps with the plan installed. Overall, maximum ebb current velocities throughout the water column at all stations in Kings Bay were slightly higher than base.

Plan P4-7

43. The effects of Plan P4-7 on water surface elevations are presented in Plates 40-43. Changes at stations other than station 10 were minor, as most changes were on the order of ±0.1 ft. Low-water elevation at station 10 were 0.7 ft higher than base, while high-water elevation were about 0.3 ft higher. This resulted in an increase in the tidal plane about 0.5 ft, and decreased the tide range by about 0.5 ft.

44. The effects of the plan on flow predominance values are shown in Figures 9-11. These data show that flow was generally increased in the flood direction along the entire length of the navigation channel. The more evident changes occurred in Kings Bay and immediate area. With the exception of only a single data point (station 2074 middepth), all data collected upstream from station 1182 showed a very dramatic increase in flow predominance in the flood direction.

45. Effects of the plan on maximum current velocities are shown in Figures 12-14. These data show that the plan had very little impact on current velocities along the navigation channel, except in Kings Bay area. Maximum flood current velocities in the navigation channel downstream from Kings Bay were increased slightly by the plan. Maximum current velocities in Kings Bay

during base conditions were decreased from about 0.5-1.5 fps to less than 0.5 fps.

Plan P4-8

46. The effects of Plan P4-8 on water surface elevations are shown in Plates 79-82. This plan resulted in very little change to water surface elevations throughout the estuary. Changes were generally well within the limits of model repeatability. The greatest effects were observed at station 10, where low-water elevation was 0.1 ft higher than base and high-water elevation was 0.1 ft lower than base. These differences in elevations resulted in a range increase of 0.2 ft.

47. Effects of the plan on flow predominance values at stations along the navigation channel centerline are shown in Figures 15-17. Effects at the surface depth in the downstream portion of the navigation channel were generally toward weaker ebb flow, while flow predominance values in Kings Bay and immediate vicinity were influenced in the opposite direction toward a stronger ebb flow predominance value. Middepth values followed the same general trend as observed at the surface. Flow predominance values in the downstream portion of the channel were changed toward weaker ebb flow, while in Kings Bay area, weak flood flow predominance values were generally changed toward a weaker flood flow. Flow predominance values at the bottom depth were erratic, as increased in the flood direction was observed near the estuary entrance; in the mid portion of the navigation channel (sta 1055-1851) flow predominance values were increased toward the ebb direction; while flow predominance values in Kings Bay and immediate area were generally changed toward increased flood flow.

48. Effects of the plan on maximum current velocities along the navigation channel are shown in Figures 18-20. These data show that maximum current velocities along the channel were changed very little except in Kings Bay area, where both maximum ebb and flood current velocities were increased. Maximum current velocities in Kings Bay with the plan installed were generally on the order of 1.0 to 2.0 fps. Surface current velocities were usually slightly higher.

Plan P4-9

49. The effects of Plan P4-9 on water surface elevations are shown in Plates 79-82. Very little change was observed throughout the estuary. The water surface plane was lowered about 0.1 ft in Kings Bay with no change in tidal phase. Low-water elevation at station 10 was raised 0.2 ft, and high-water elevation was lowered 0.1 ft, resulting in an increase in tide range at this location of 0.3 ft. There was no phase shift observed at station 10.

50. The effects of Plan P4-9 on flow predominance values are shown in Figures 15-17. These data show that the plan had very little effect on flow predominance values in the navigation channel except in Kings Bay and immediate area. As expected, with the gate open during ebb tide, the flow predominance values in Kings Bay were increased in the ebb direction at all depths. The overall effect was to change weak flood predominance values into rather strong ebb flow predominance values throughout Kings Bay. Flow predominance values at station 1014 followed the same general trend as observed in Kings Bay.

51. Effects of the plan on maximum current velocities along the navigation channel are shown in Figures 18-20. Generally, maximum current velocities downstream from Kings Bay were changed very little. Maximum flood and ebb current velocities in Kings Bay and immediate area were decreased, and increased, respectively, by the plan. Maximum flood current velocities were decreased to about 0.1-0.3 fps, and maximum ebb current velocities were increased to about 1.0-2.0 fps. The largest increase occurred at station 2089, where maximum current velocities of 4.8 fps, 3.6 fps, and 0.8 fps were observed at the surface, middepth and bottom depths, respectively. Maximum current velocities observed at this location during base tests were on the order of 1.0 fps to 1.5 fps. Very little change was observed at station 1014, located north of Kings Bay.

Plan P4-10

52. The effects of Plan P4-10 on water surface elevations are shown in Plates 79-82. Very little change was observed outside the immediate vicinity of Kings Bay. The water surface plane was lowered 0.1 ft at stations 6 and 7, located at Kings Bay entrance and the upper end, respectively. The greatest

effect was observed at station 10, located north of Kings Bay. Low-water at this location was raised 0.4 ft and high-water was lowered 0.3 ft, resulting in a range decrease of 0.7 ft. The phase of low water was shifted later by about 30 min.

53. The effects of Plan P4-10 on flow predominance values are shown in Figures 15-17. Very little effects were observed along the navigation channel outside Kings Bay. Overall, the small changes noted outside Kings Bay were toward increased flood flow. Flow predominance values at all depths in Kings Bay were changed to strong flood flow, as expected, since the gate was open during the flood tide and closed during the ebb tide.

54. The effects of the plan on maximum current velocities are shown in Figures 18-20. Very little effects were observed along the navigation channel except in Kings Bay and immediate area. Maximum current velocities in Kings Bay were generally decreased by the plan.

PART VI: REPEATABILITY TESTS

55. Tests were conducted in the physical model to determine its repeatability. Tidal height data were collected at 6 locations and current velocity data at 12 locations. The location of the stations monitored during this phase of the study are show in Figure 1. The basic plan channel, Plan P4-1, condition (no remedial measure) was installed in the model throughout this phase of the study. Data collection was accomplished on two separate days, approximately 1 week apart. The procedure followed each day was to start the model and run to salinity stability prior to initiation of data collection. Both tidal and current velocity data were collected during the morning sampling period and again during the afternoon period. This sequence was repeated on the second day.

56. Current velocities were monitored for three tidal cycles during each of the 4 sampling periods (12 data sets). A single current velocity meter was assigned to each station and only that meter was used for that station throughout this phase of the study.

57. The analysis of the tidal repeatability data are presented in Appendix B of Granat and Brogdon.* A summary of this analysis showed that the maximum deviation in individual measurements was 0.2 ft with no readily apparent systematic pattern. Almost systematic deviation of 0.1 ft occurred between two-cycles averages.

58. Only the current velocity data obtained at middepth during the repeatability tests were statistically analyzed. The results are presented in Table 1 and in Plates 118-129. The other data (surface and bottom) are on file at WES. Generally, model repeatability was within ±0.5 fps during the tidal cycle, but averaged within ±0.25 fps. The model data was therefore averaged for three tidal cycles to reduce variability to ±0 25 fps overall.

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* Mitchell A. Granat and Noble J. Brogdon. "Cumberland Sound and Kings Bay Pre-Trident and Basic Trident Channel Hydrodynamic and Sediment Transport Hybrid Modeling" (in preparation), US Army Engineer Waterways Experiment Station, Vicksburg, MS.

PART VII: CONCLUSIONS

59. Each of the nine plans investigated had minimum impact on base condition water surface elevations and currents downstream from Kings Bay. The greatest impact of each plan on water surface elevations was observed at Station 10, located in Marianna Creek north of Kings Bay. The greatest impact of the plans on current velocities and flow predominance was observed in or near Kings Bay. Both magnitude and direction of change were dependent on the particular plan.

60. The results of the repeatability study demonstrates that the model was reproducing both water surface elevations and currents within an acceptable degree of accuracy; therefore, the results could be successfully used as boundary conditions for numerical models.

Table 1

Statistical Analysis of Kings Bay Physical Model Mid-Depth Current Velocity Repeatability Tests Data (Velocity in fps)

Station ID	Standard Deviation			Mean Velocity	
	Maximum	Minimum	Average	Maximum Flood	Maximum Ebb
60	0.27	0.06	0.15	1.59	-1.94
160	0.29	0.08	0.18	1.46	-1.81
230	0.69	0.10	0.32	2.60	-3.47
650	0.31	0.03	0.18	1.57	-2.52
812	0.39	0.09	0.17	2.28	-4.50
818	0.27	0.07	0.15	2.10	-3.04
843	0.42	0.08	0.25	2.21	-3.97
1385	0.29	0.03	0.17	1.97	-1.83
1989	0.45	0.08	0.22	2.55	-5.84
1999	0.37	0.03	0.19	0.98	-1.65
2074	0.33	0.03	0.18	0.69	-0.73
2122	0.41	0.09	0.21	3.77	-5.00

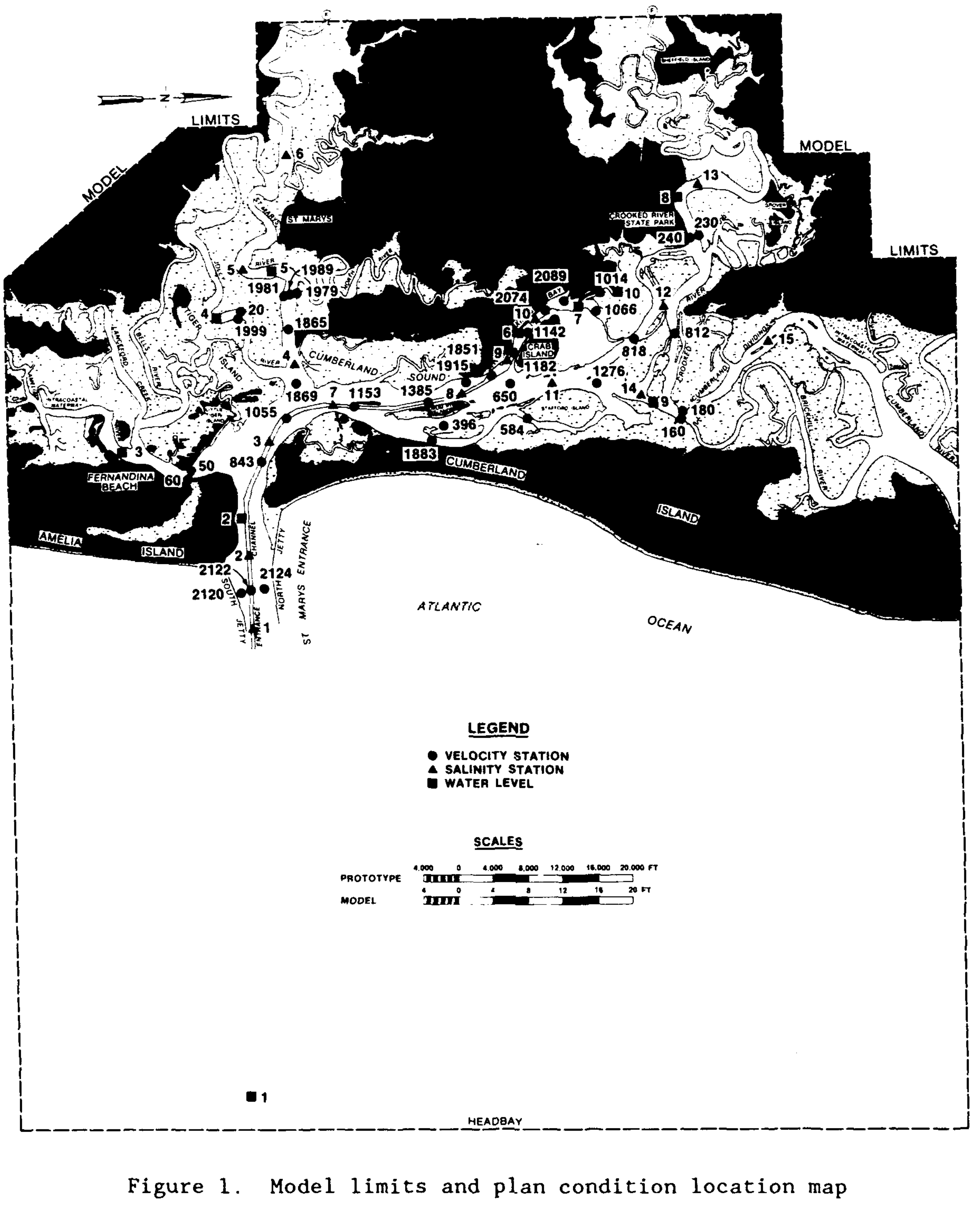


Figure 1. Model limits and plan condition location map

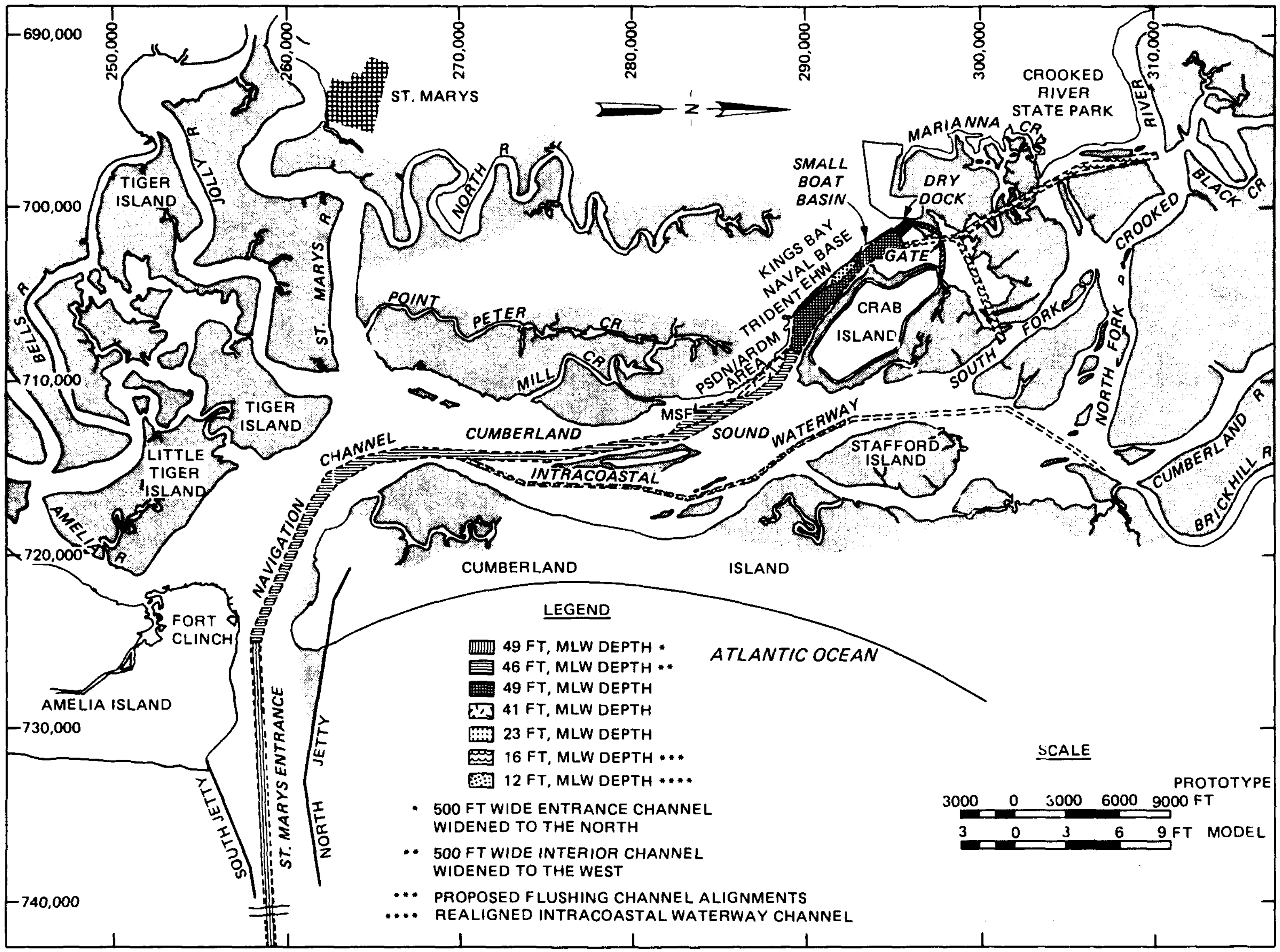


Figure 2. Elements of remedial measure plans

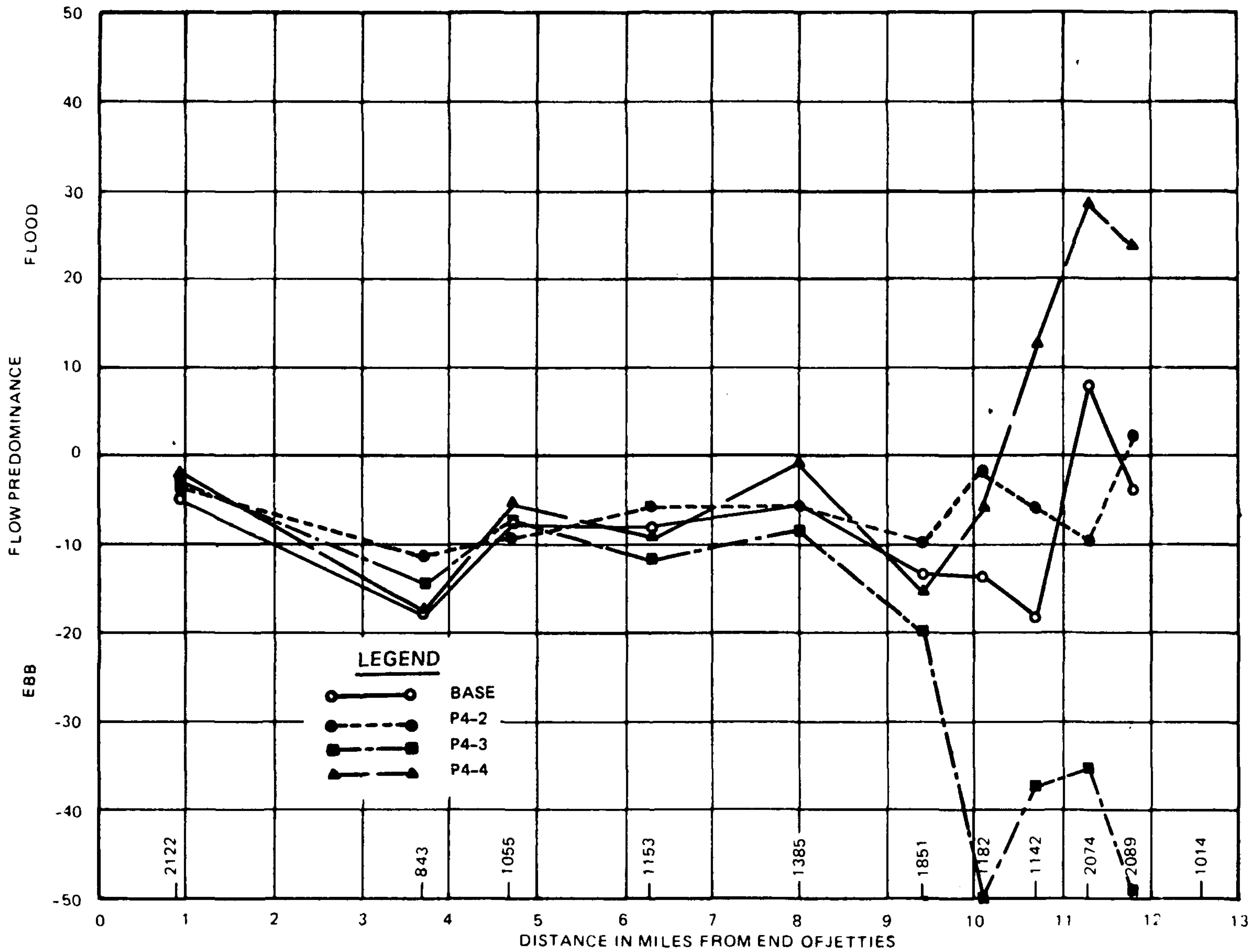


Figure 3. Effects of plans P4-2, P4-3, P4-4 on flow predominance - surface depth

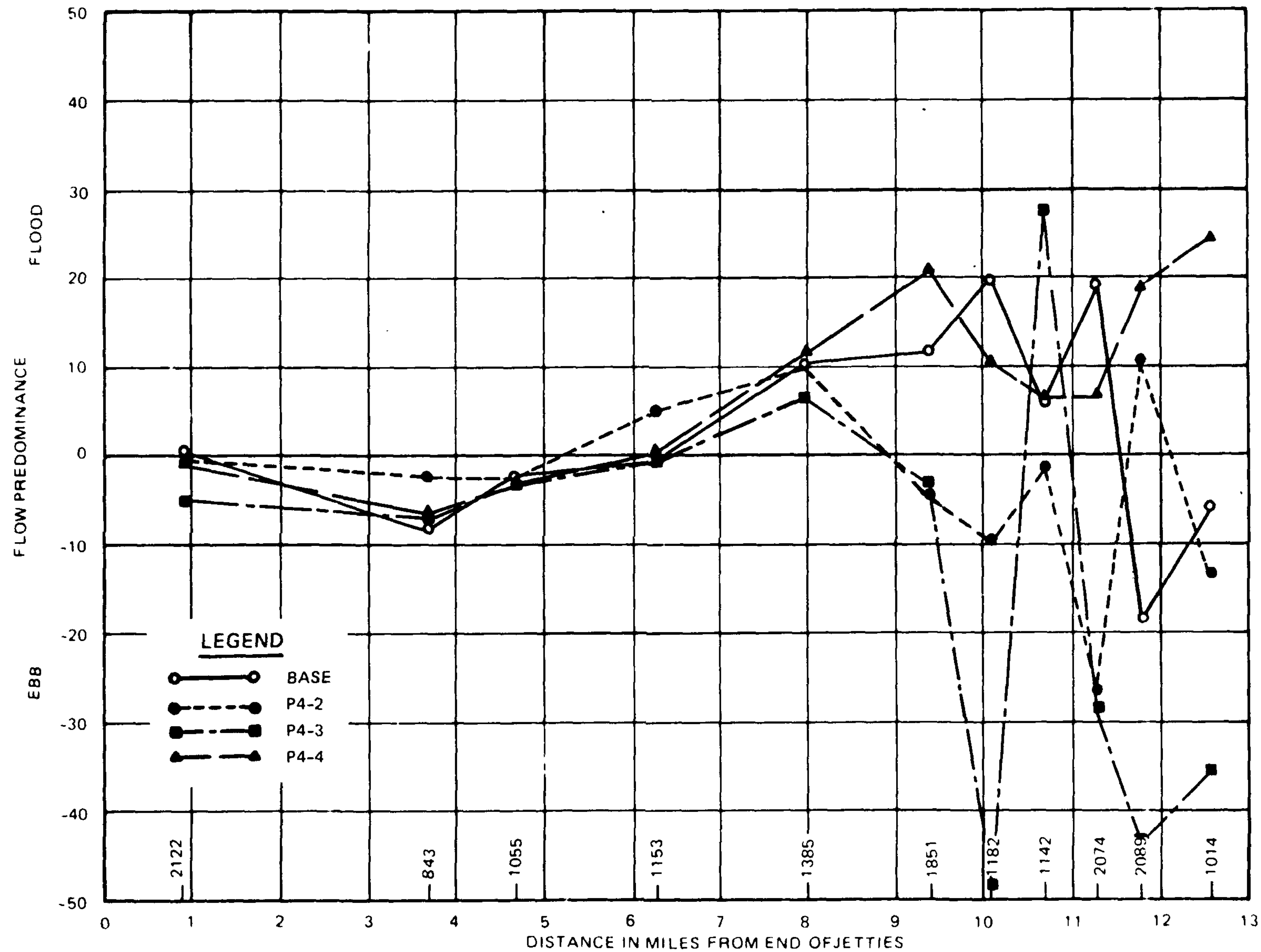


Figure 4. Effects of plans P4-2, P4-3, and P4-4 on flow predominance - middepth

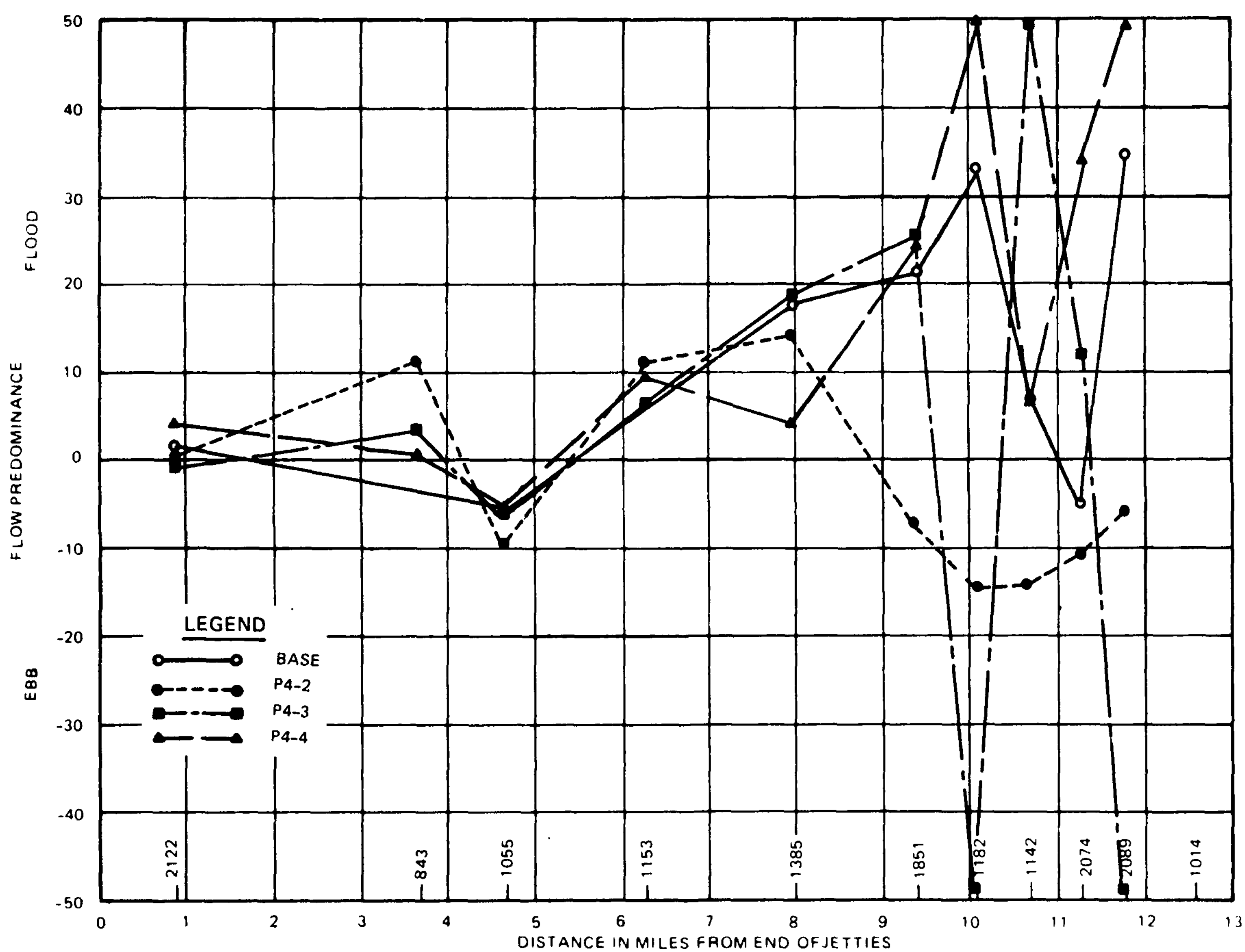


Figure 5. Effects of plans P4-2, P4-3, and P4-4 on flow predominance - bottom depth

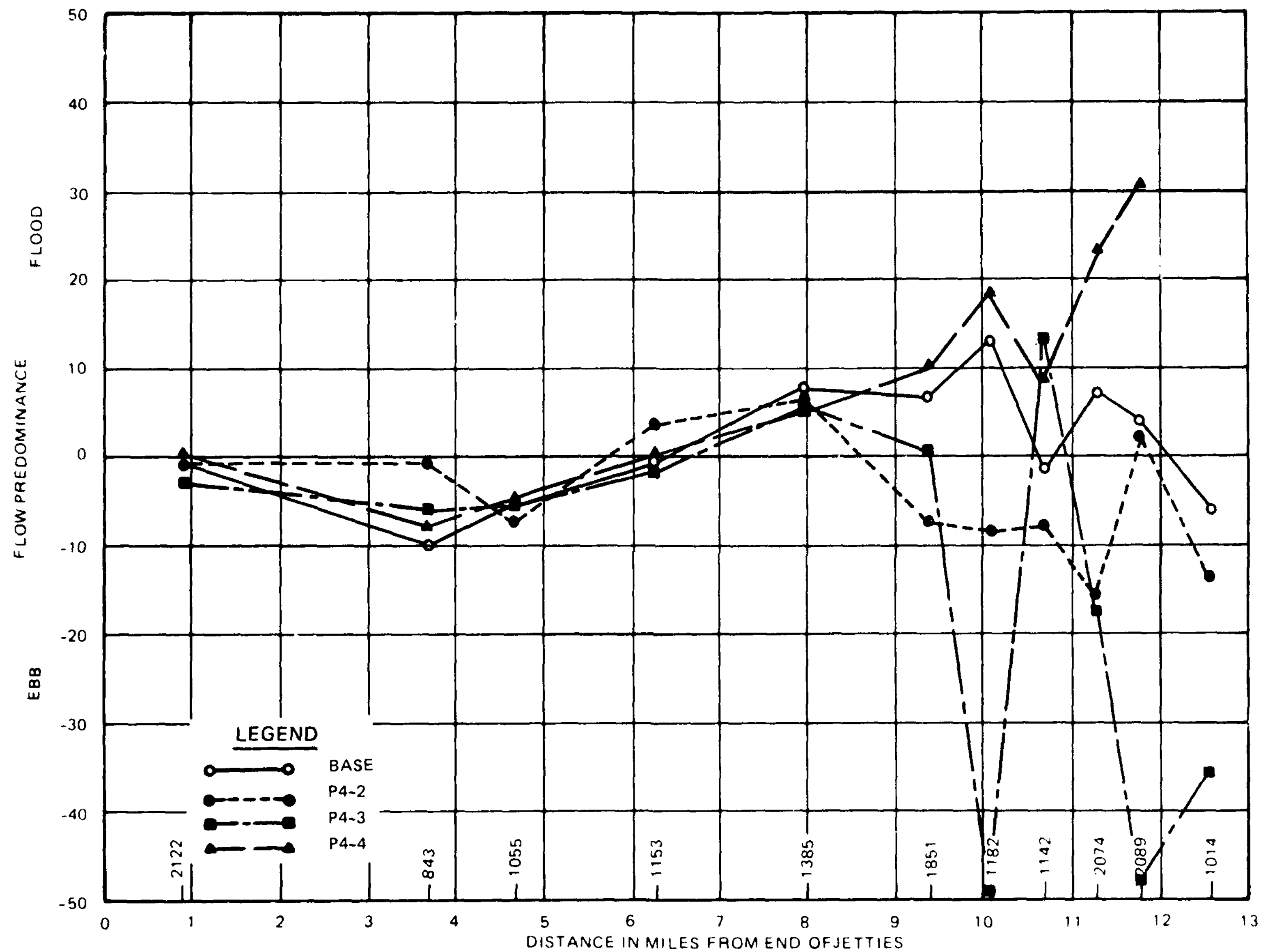


Figure 6. Maximum ebb and flood currents - surface plans P4-2, P4-3, and P4-4

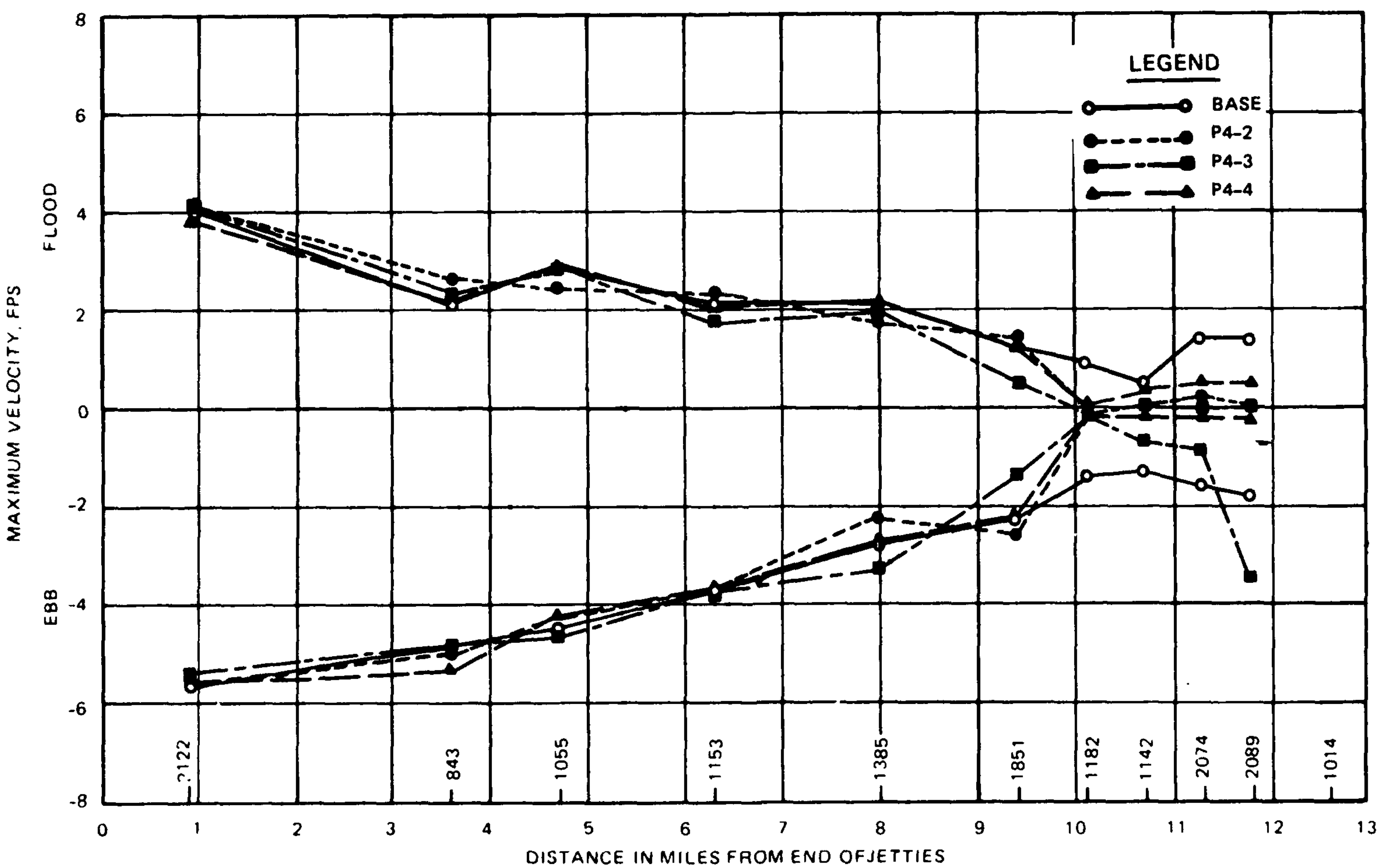


Figure 7. Maximum ebb and flood currents - middepth plans P4-2, P4-3, and P4-4

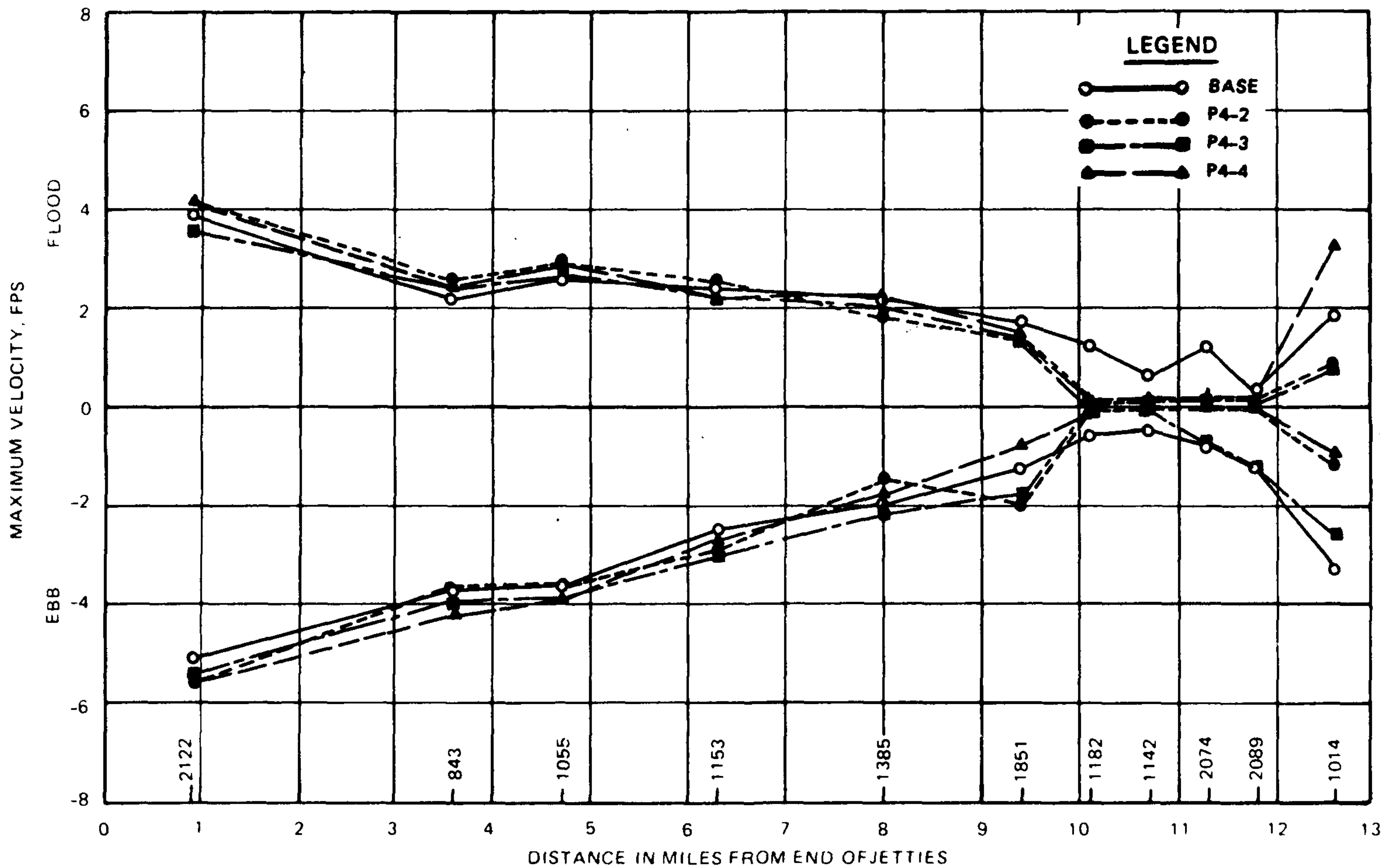


Figure 8. Maximum ebb and flood currents - bottom plans P4-2, P4-3, and P4-4

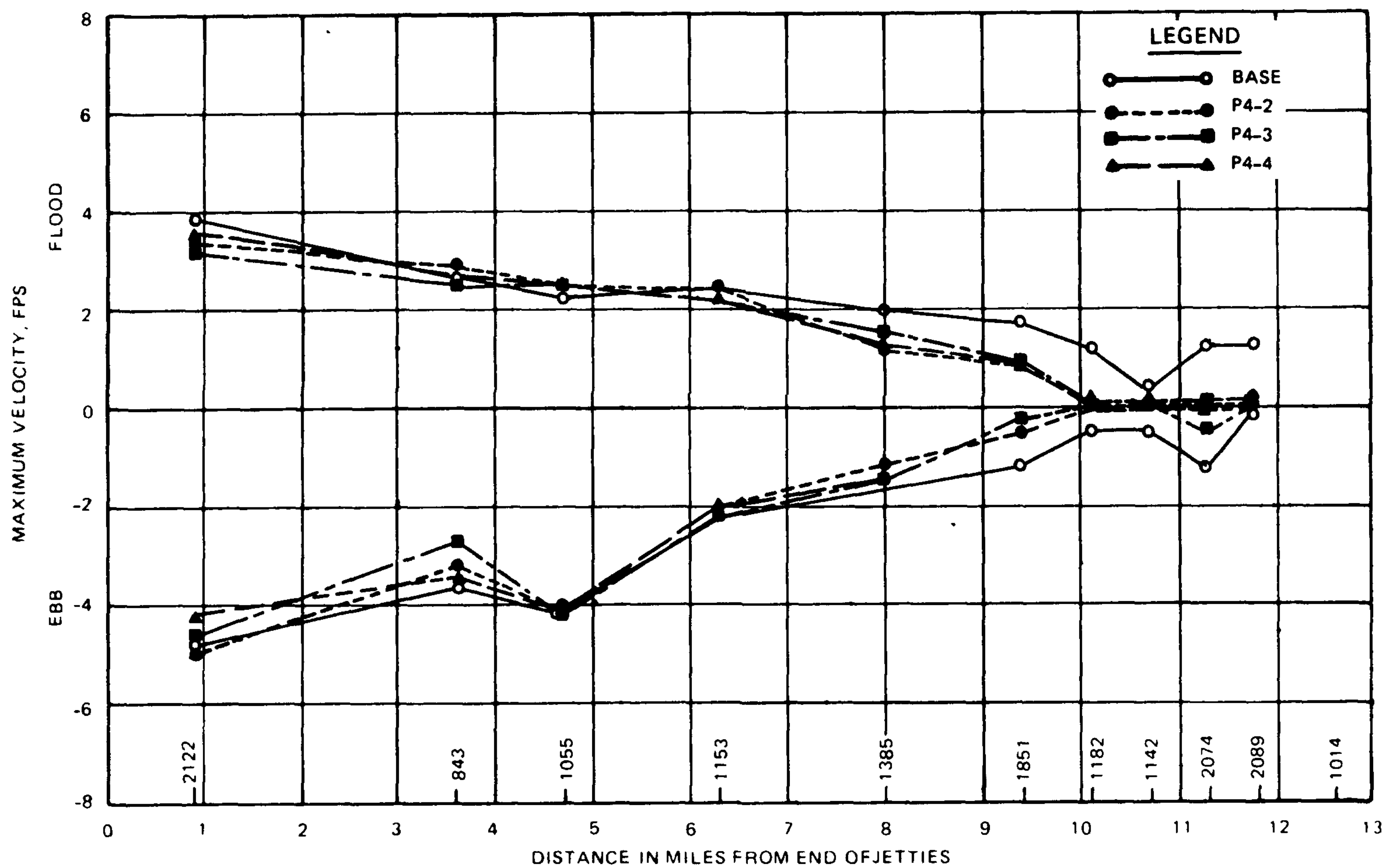


Figure 9. Effects of plans P4-5, P4-6, and P4-7 on flow predominance - surface depth

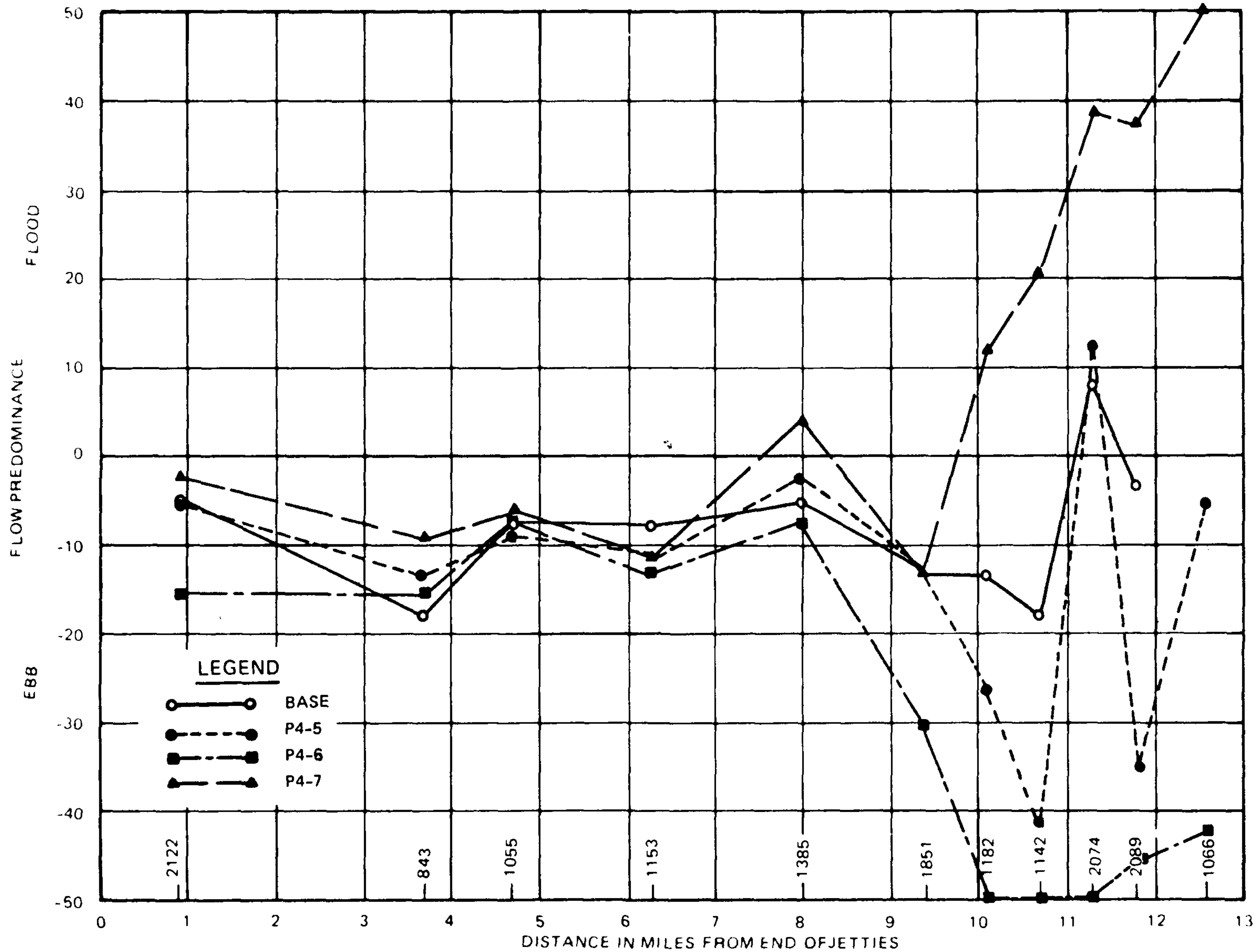


Figure 10. Effects of plans P4-5, P4-6, and P4-7 on flow predominance - middepth

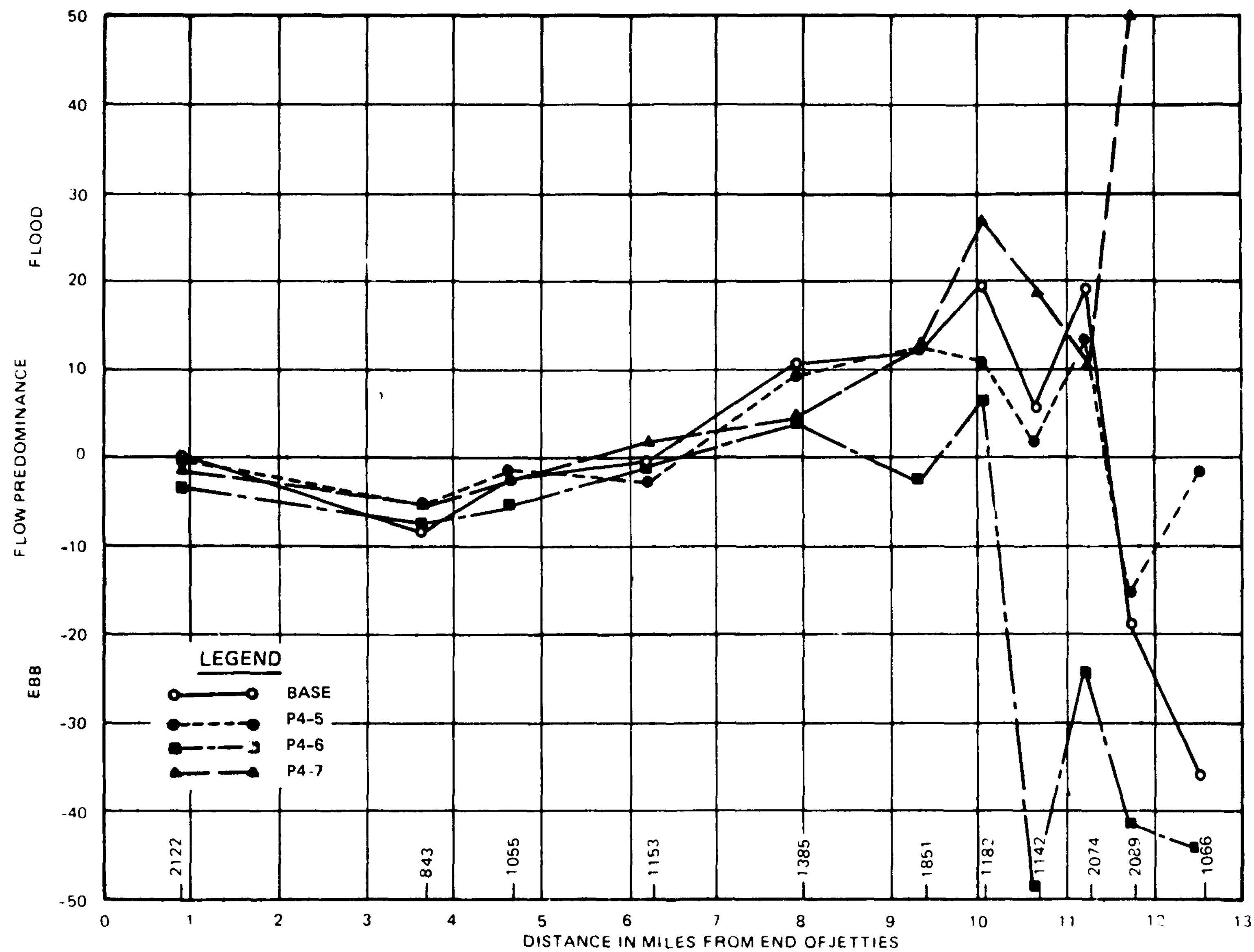


Figure 11. Effects of plans P4-5, P4-6, and P4-7 on flow predominance - bottom depth

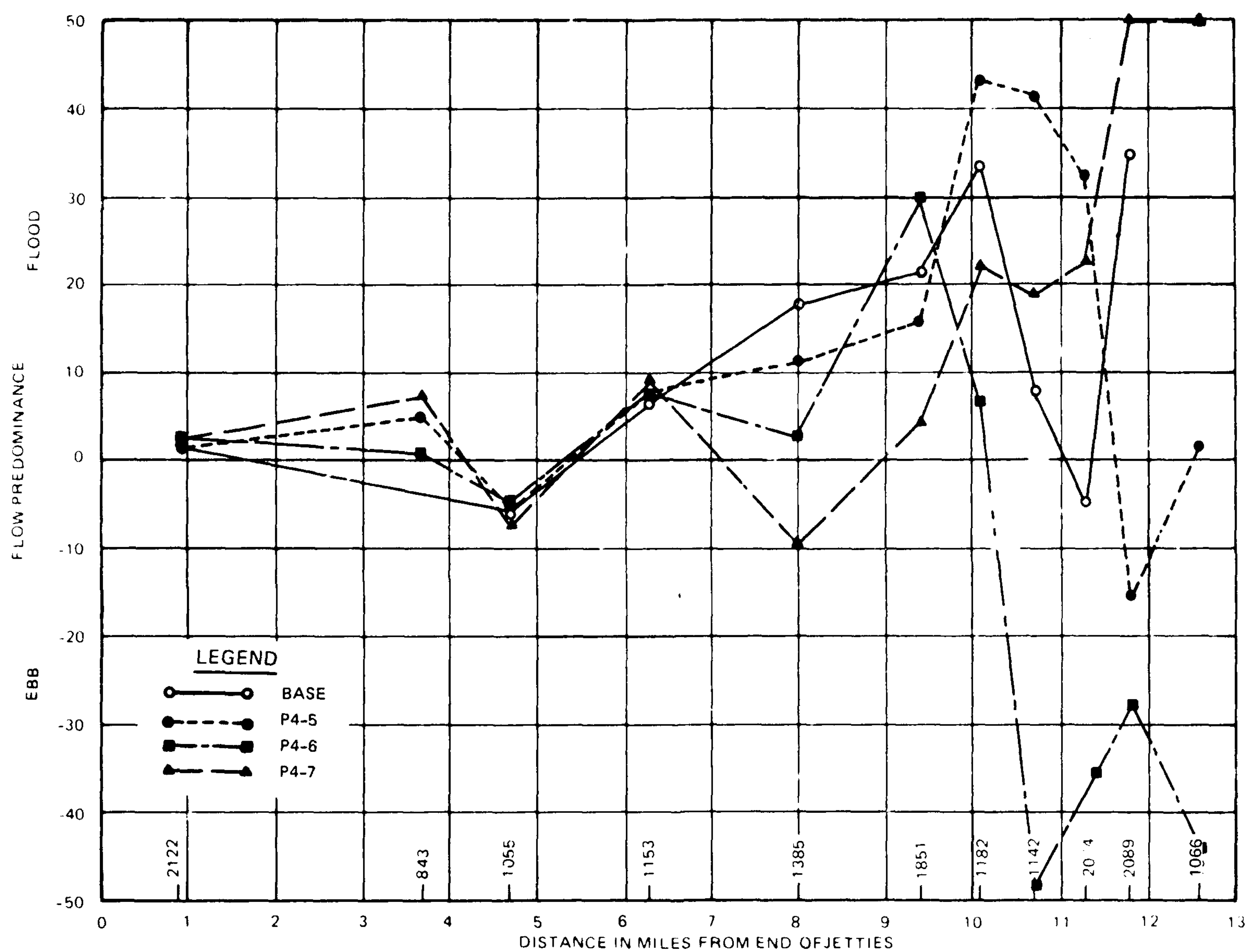


Figure 12. Maximum ebb and flood currents - surface plans P4-5, P4-6, and P4-7

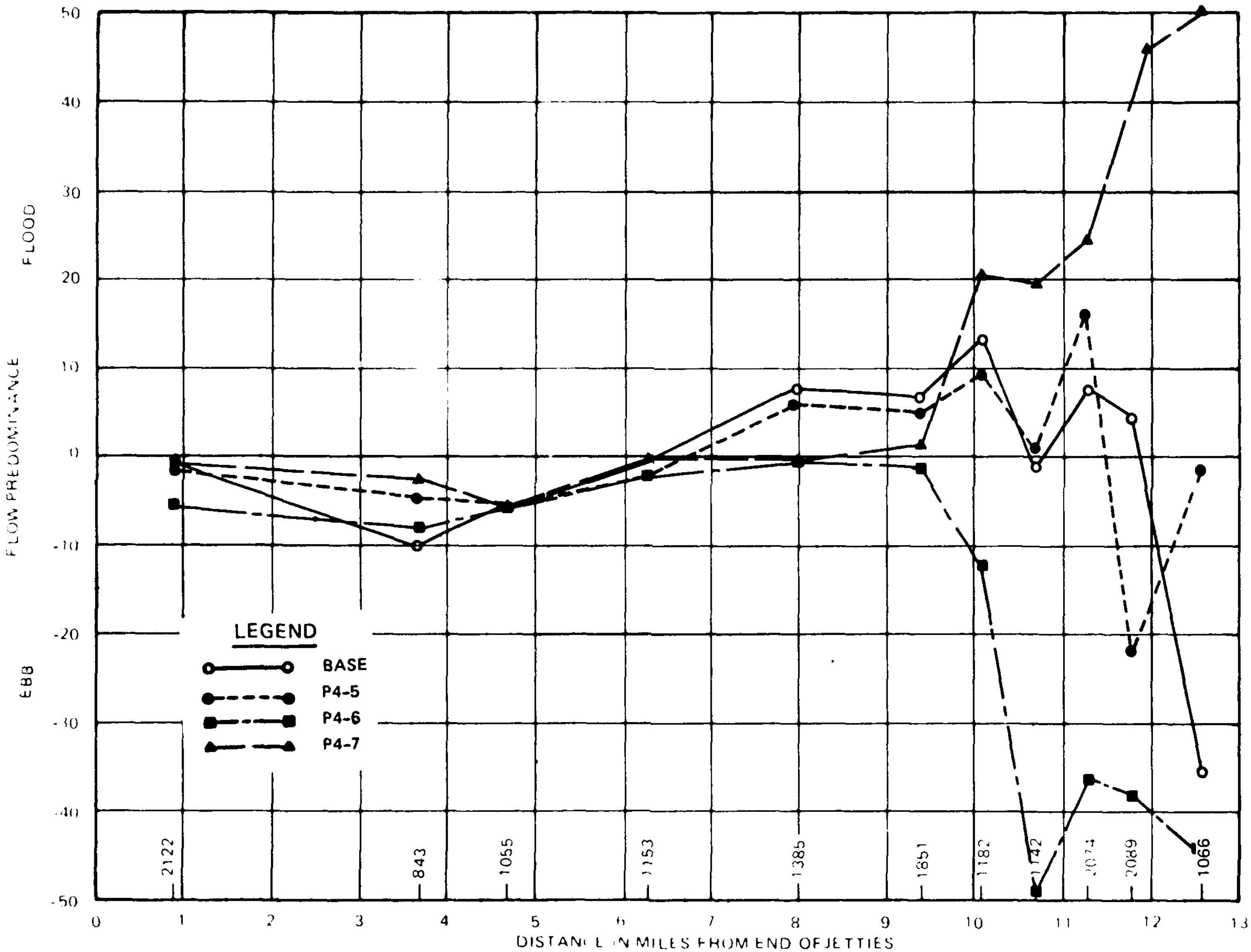


Figure 13. Maximum ebb and flood currents - middepth plans P4-5, P4-6, and P4-7

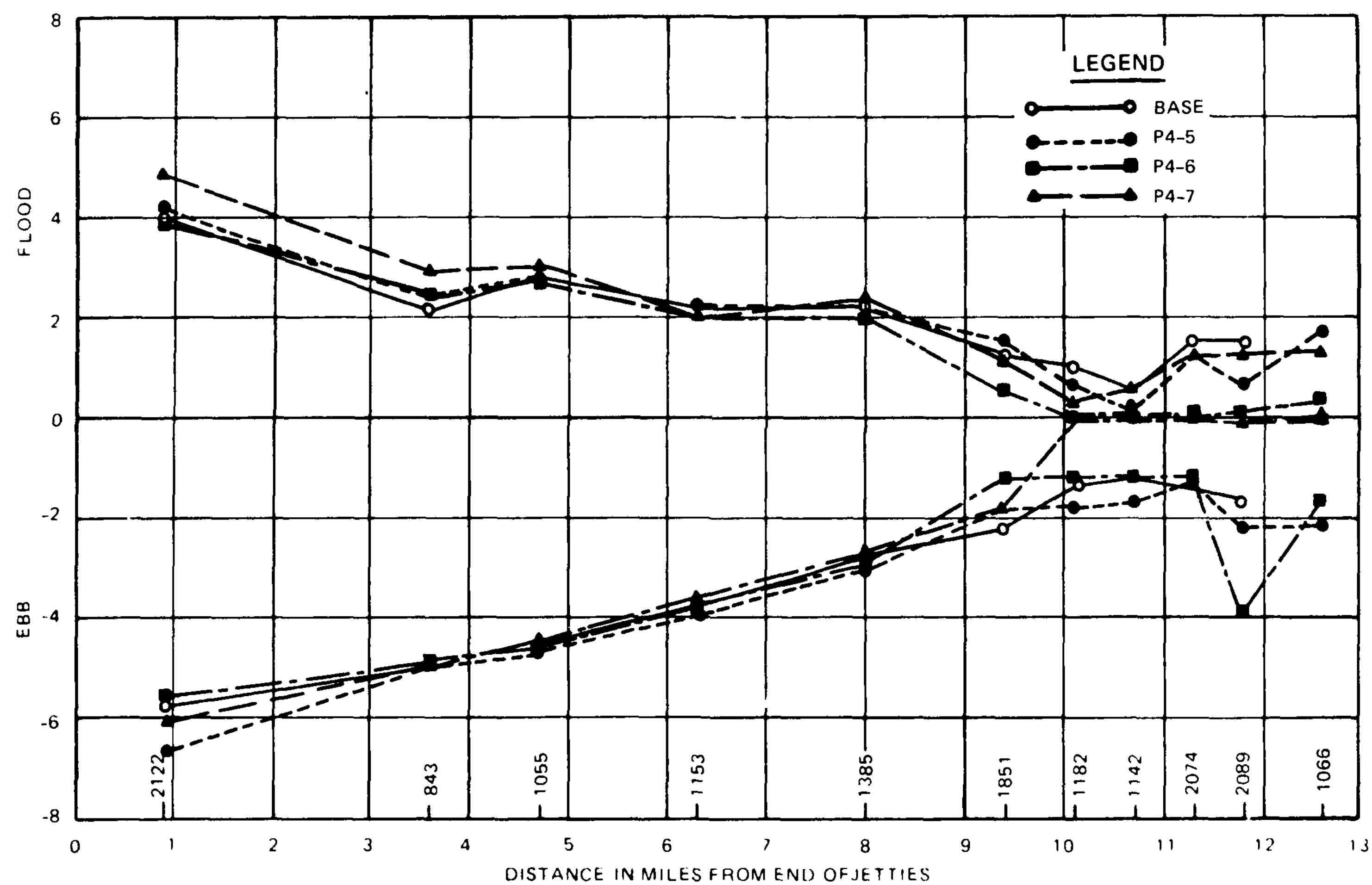


Figure 14. Maximum ebb and flood currents - bottom plans P4-5, P4-6, and P4-7

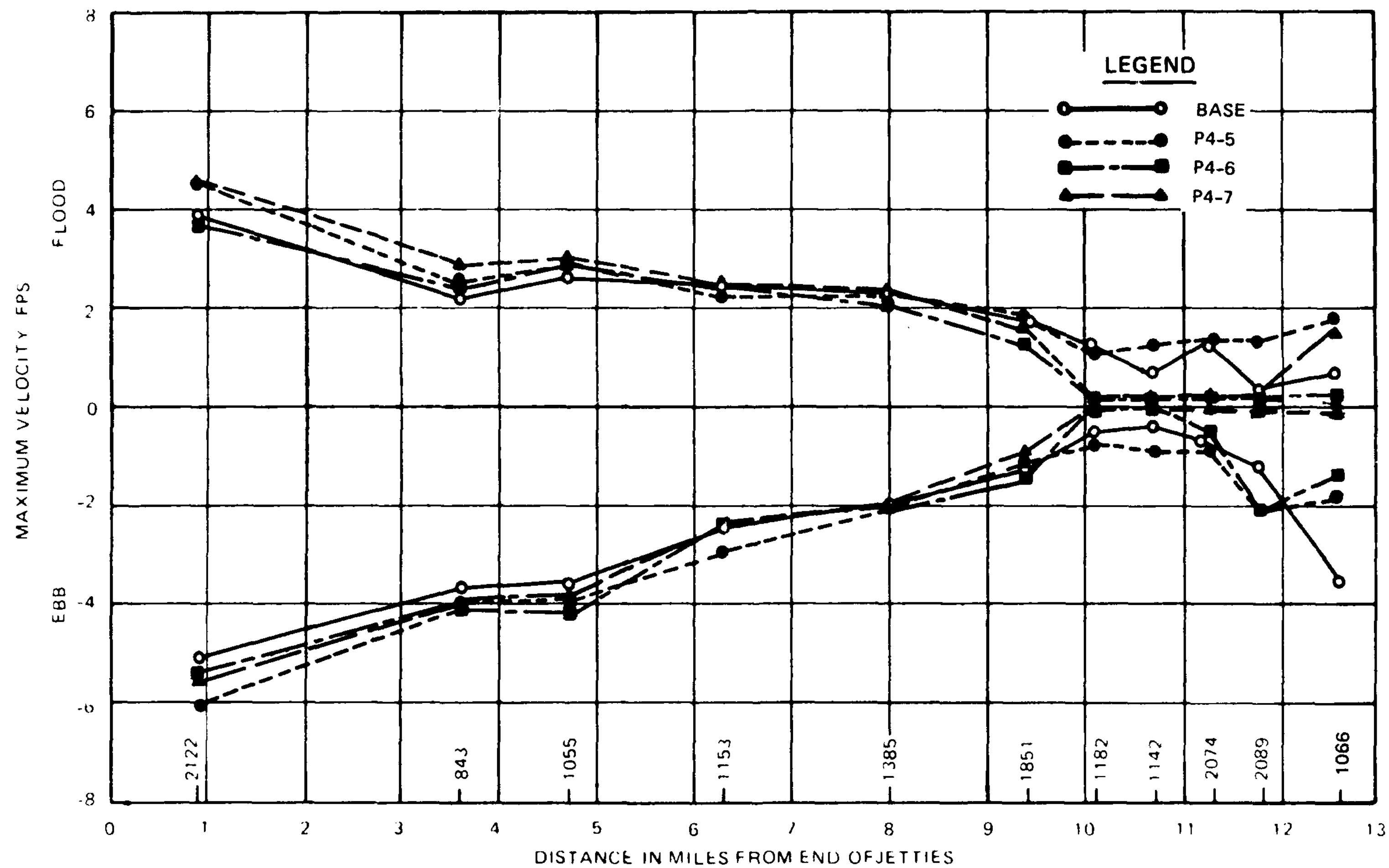


Figure 15. Effects of plans P4-8, P4-9, and P4-10 on flow predominance - surface

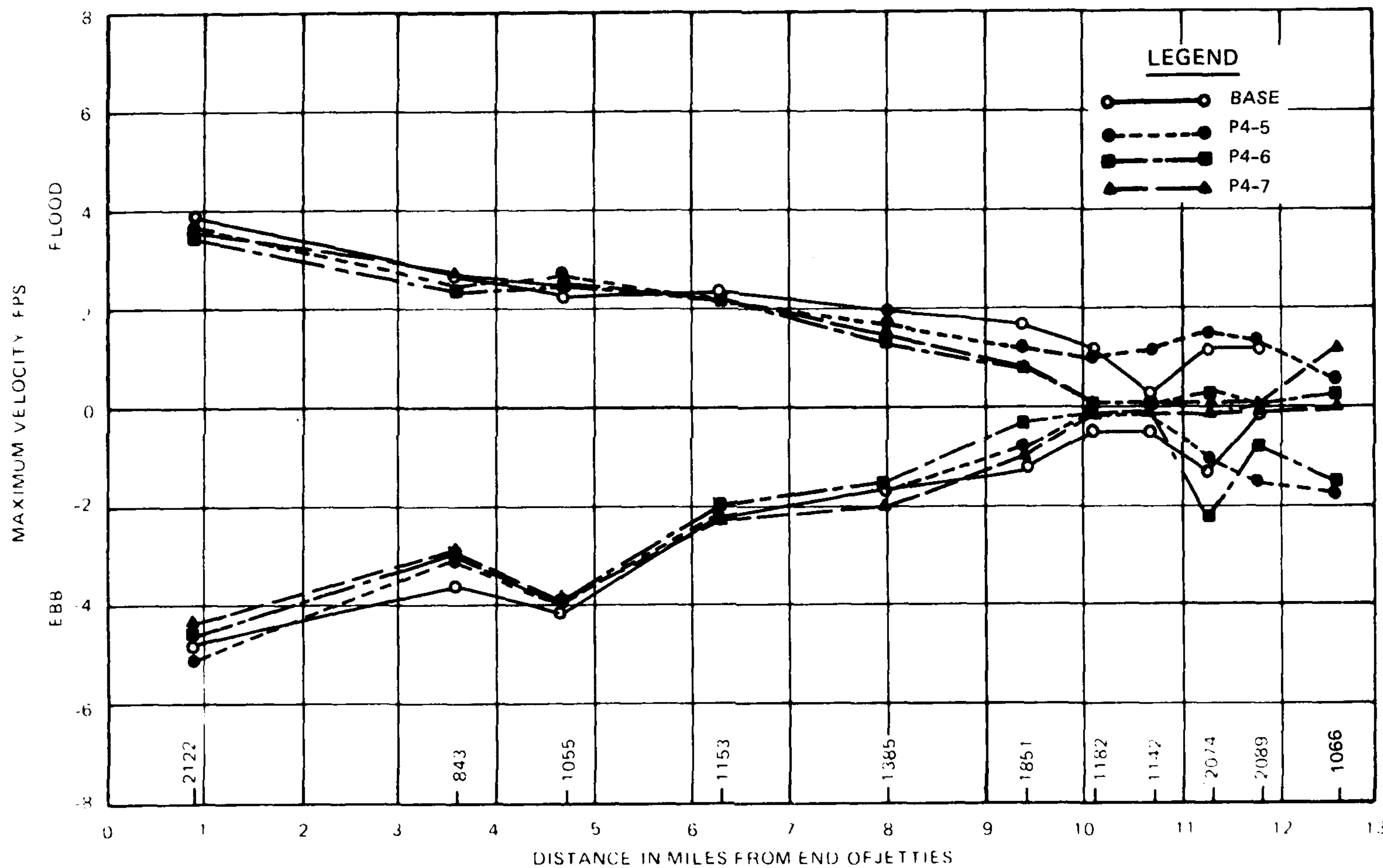


Figure 16. Effects of plans P4-8, P4-9, and P4-10 on flow predominance - middepth

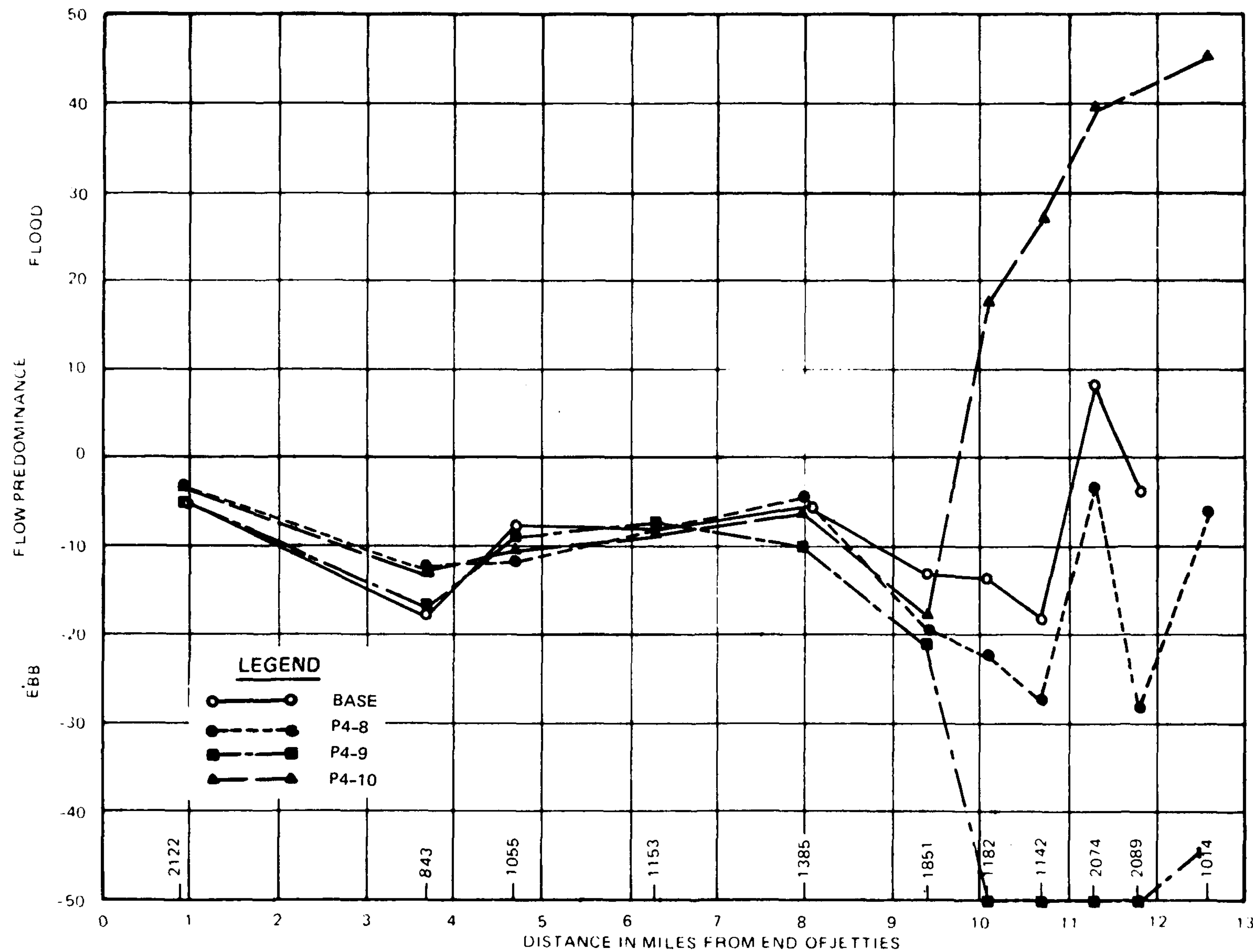


Figure 17. Effects of plans P4-8, P4-9, and P4-10 on flow predominance - bottom

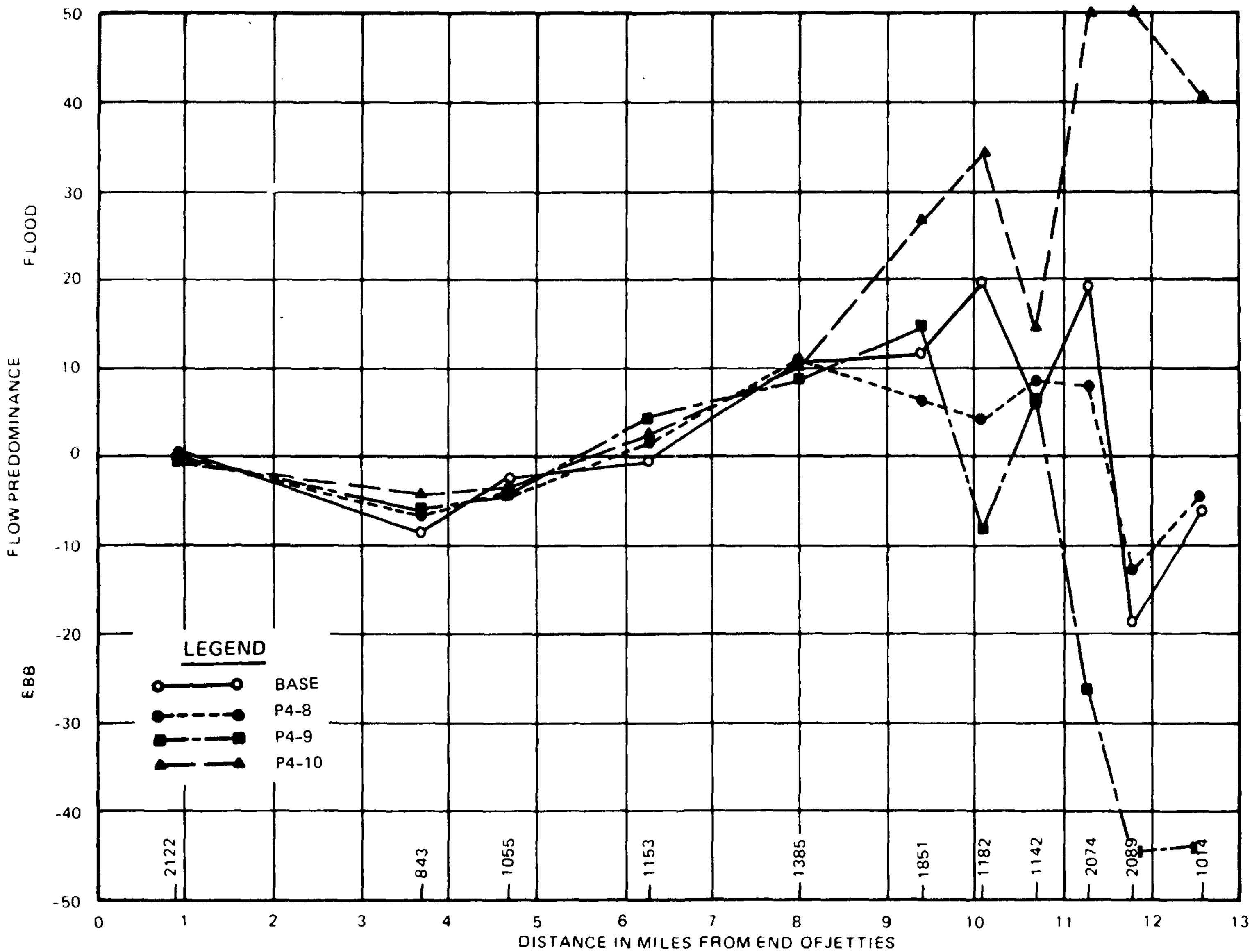


Figure 18. Maximum ebb and flood currents, surface plans P4-8, P4-9, and P4-10

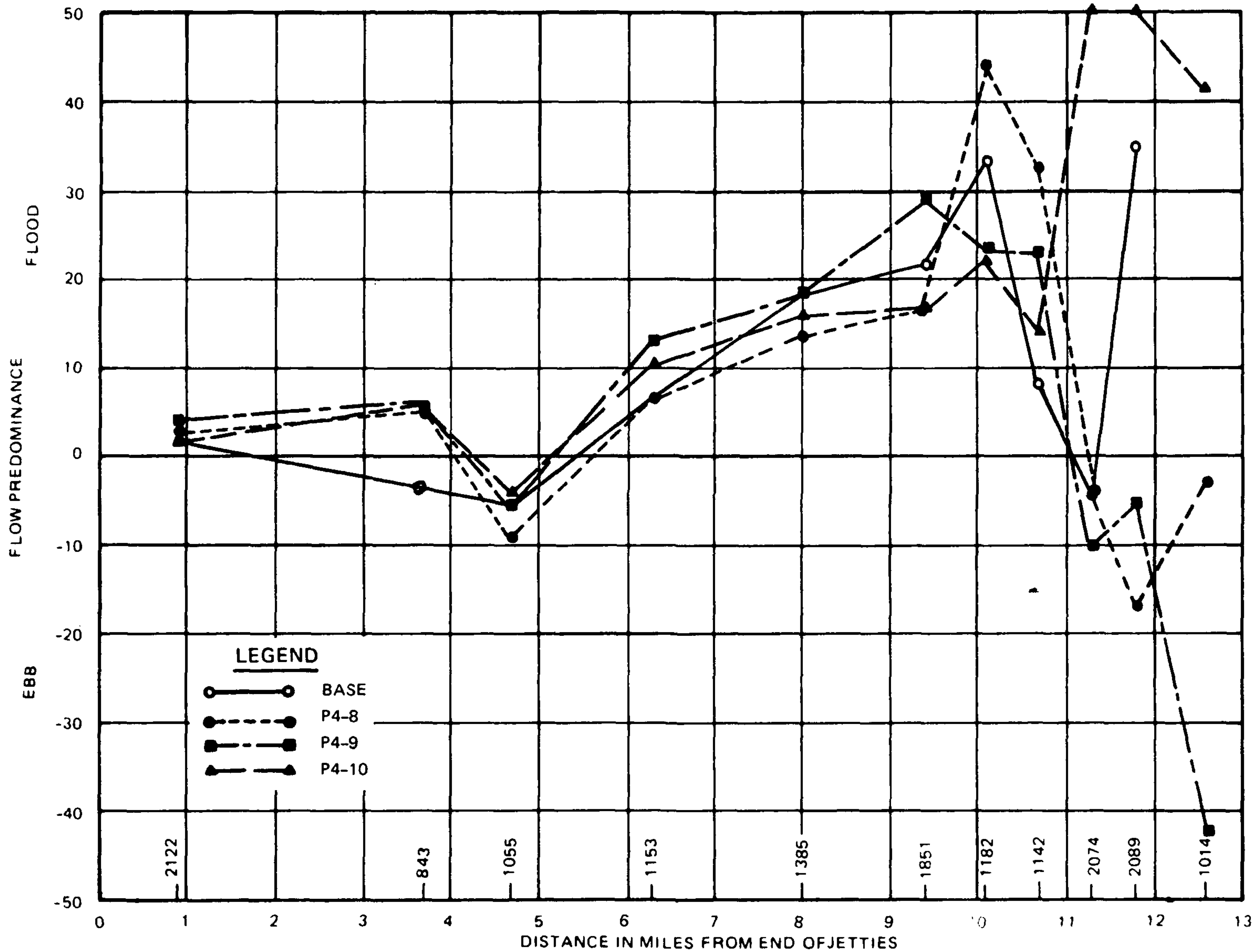


Figure 19. Maximum ebb and flood currents, middepth plans P4-8, P4-9, and P4-10

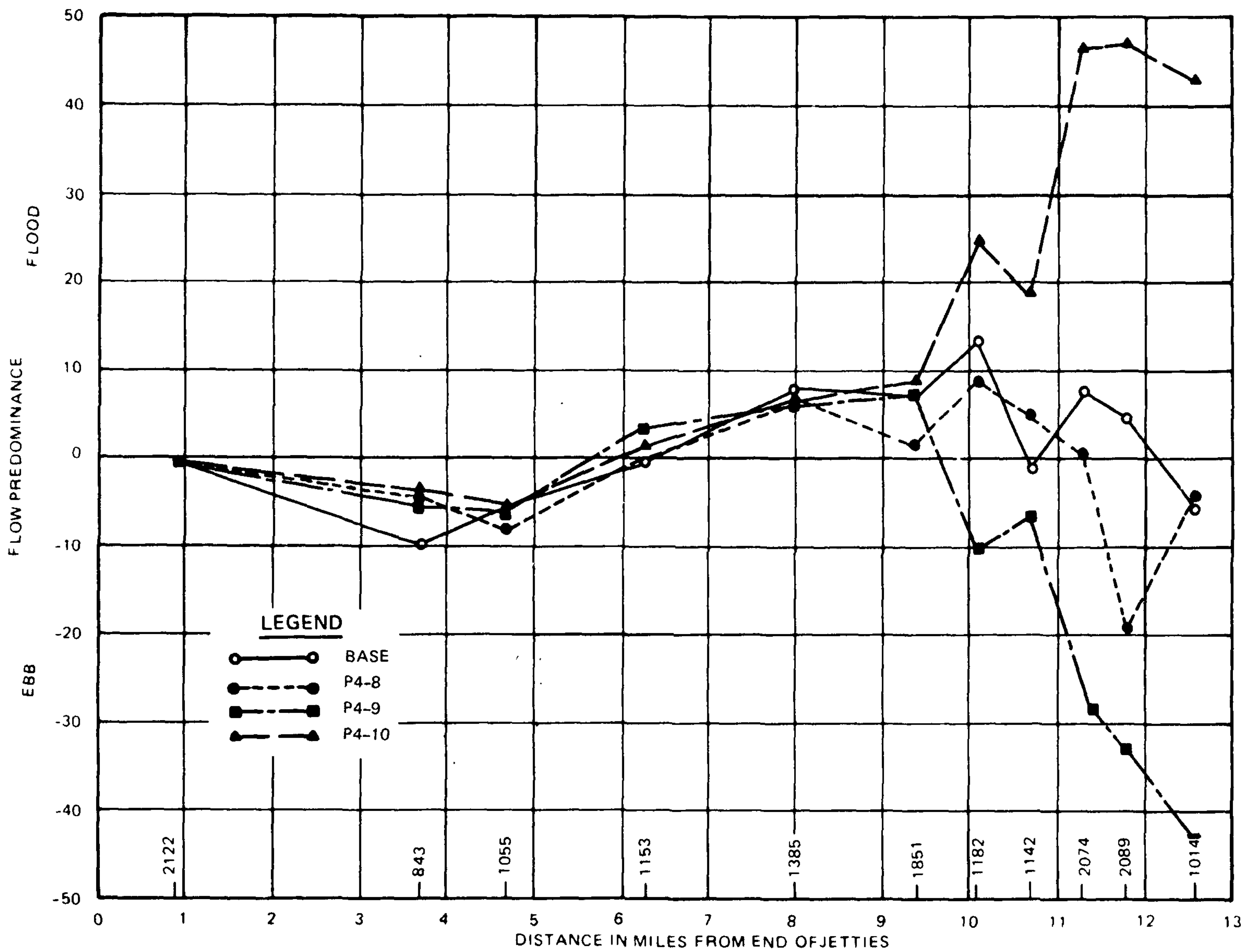
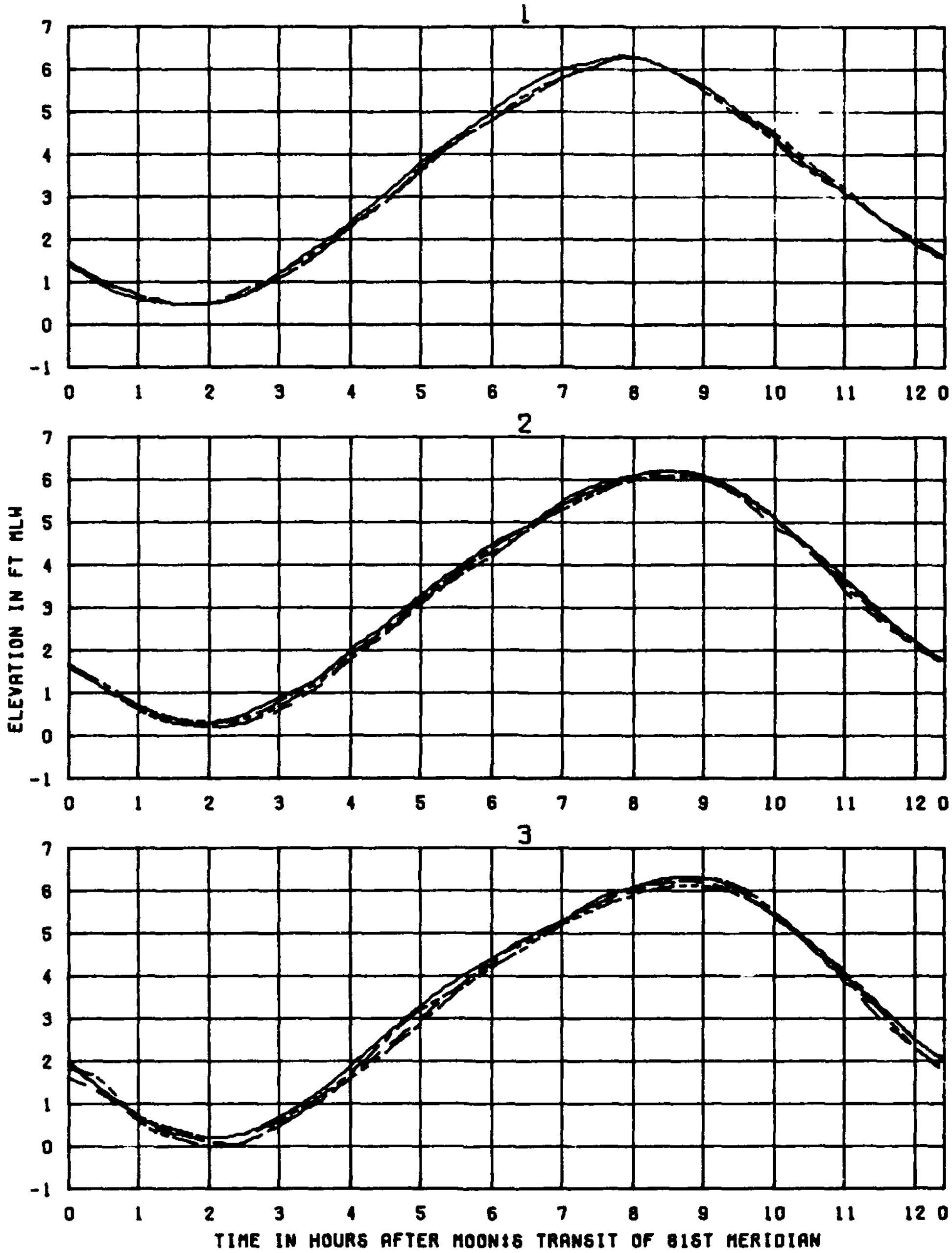


Figure 20. Maximum ebb and flood currents, bottom plans P4-8, P4-9, and P4-10



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE

PLAN 2

PLAN 3

PLAN 4

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON TIDAL HEIGHTS

STATIONS 1, 2, AND 3

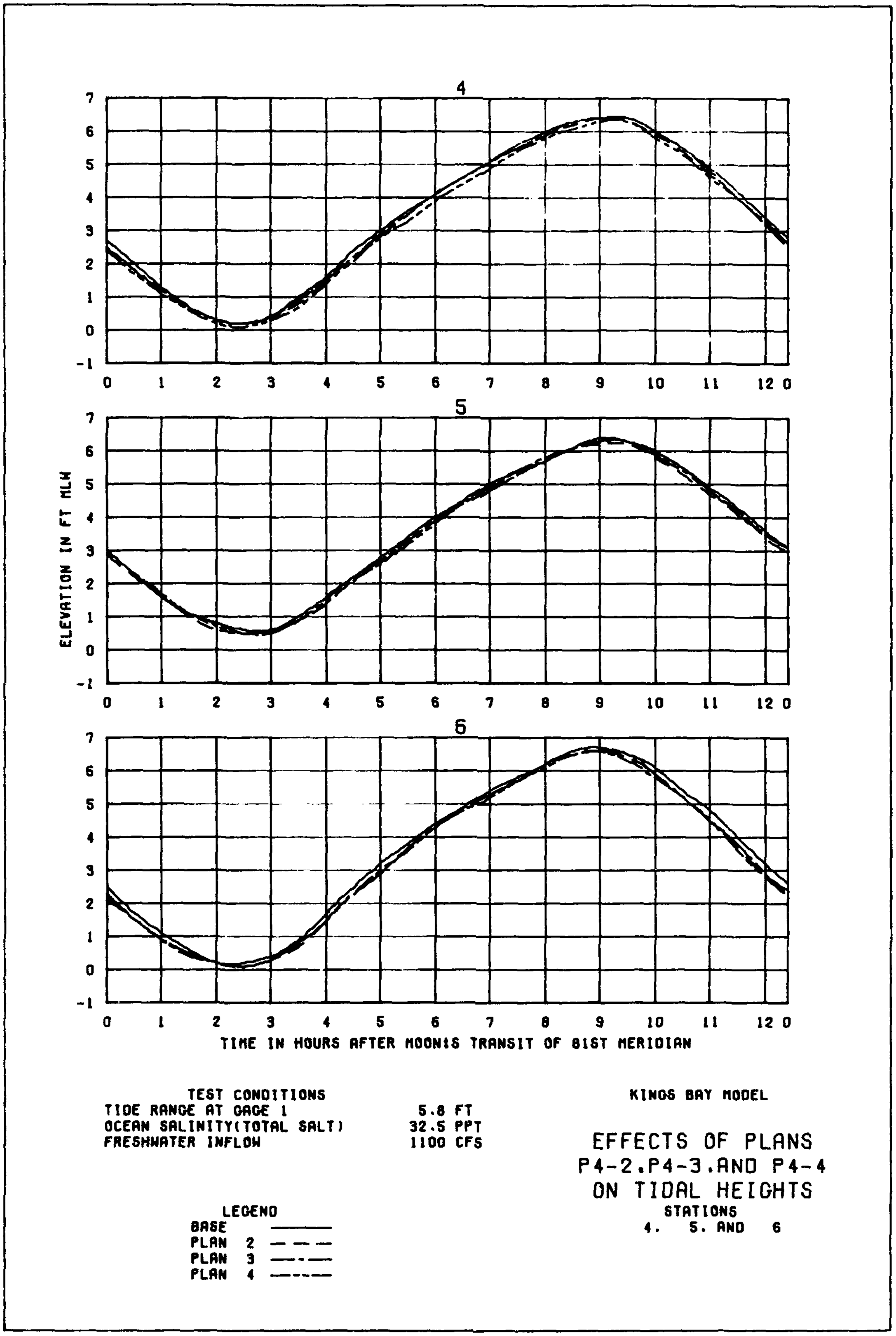
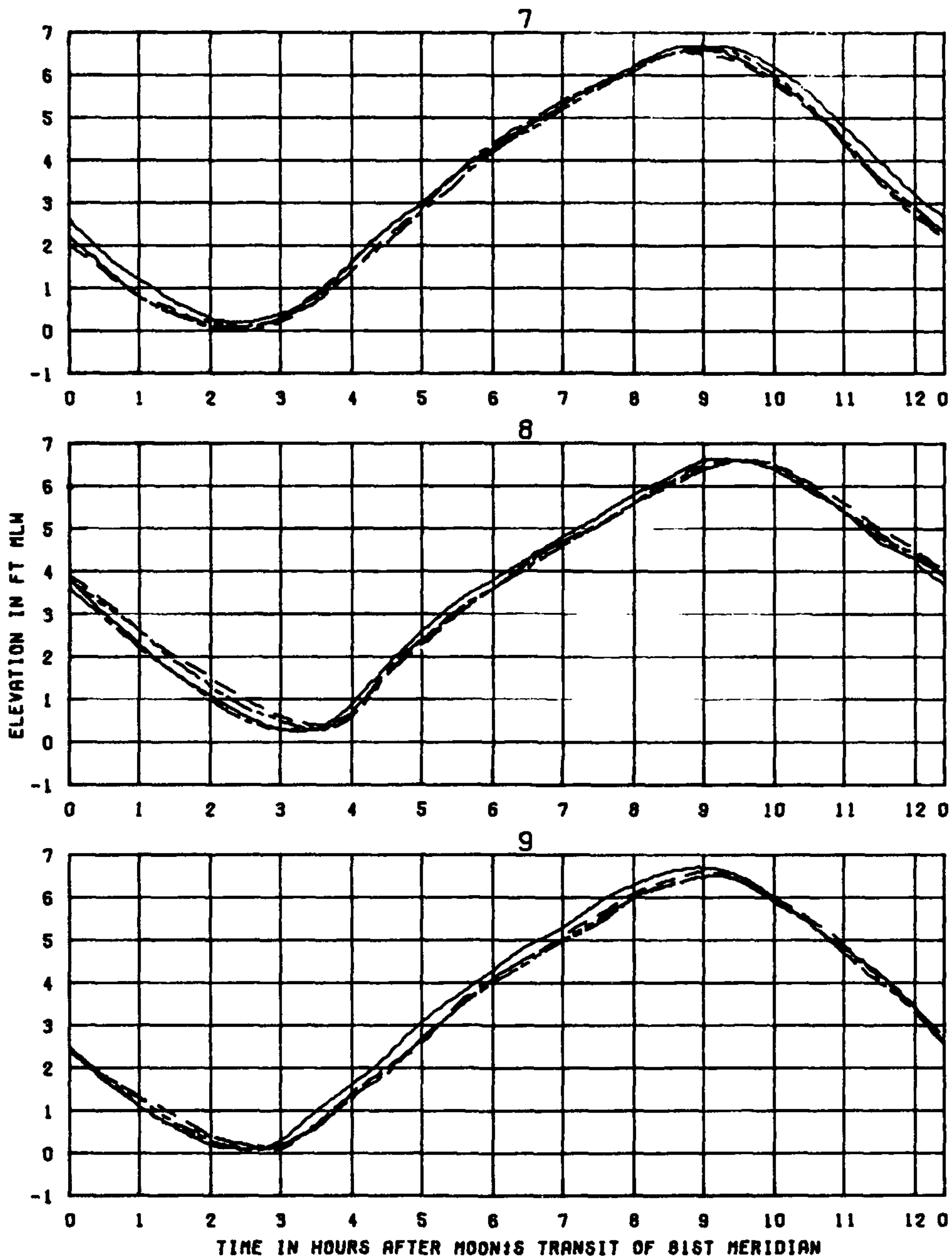

4
5
6
ELEVATION IN FT MLW
TIME IN HOURS AFTER MOON'S TRANSIT OF 81ST MERIDIAN
0 1 2 3 4 5 6 7 8 9 10 11 12 0
-1 0 1 2 3 4 5 6 7
TEST CONDITIONS
TIDE RANGE AT GAGE 1 5.8 FT
OCEAN SALINITY(TOTAL SALT) 32.5 PPT
FRESHWATER INFLOW 1100 CFS
KINGS BAY MODEL
EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON TIDAL HEIGHTS
STATIONS
4, 5, AND 6
LEGEND
BASE
PLAN 2
PLAN 3
PLAN 4

PLATE 2



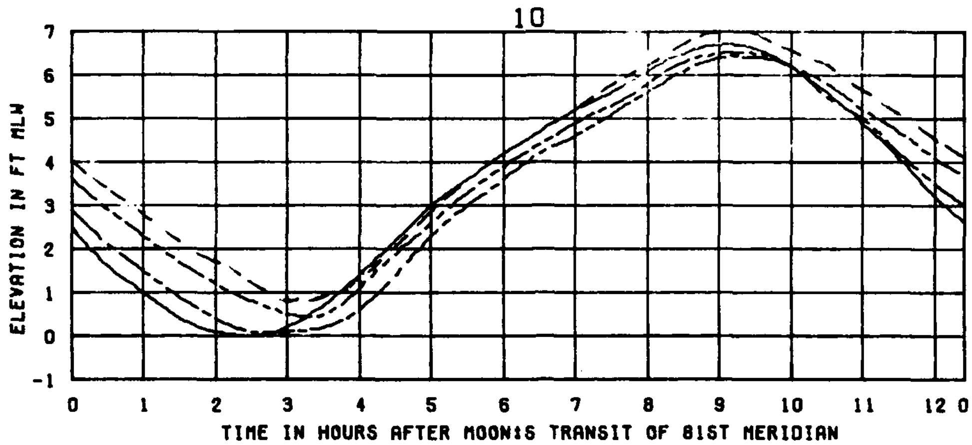
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON TIDAL HEIGHTS
STATIONS
7, 8, AND 9

LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —--—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

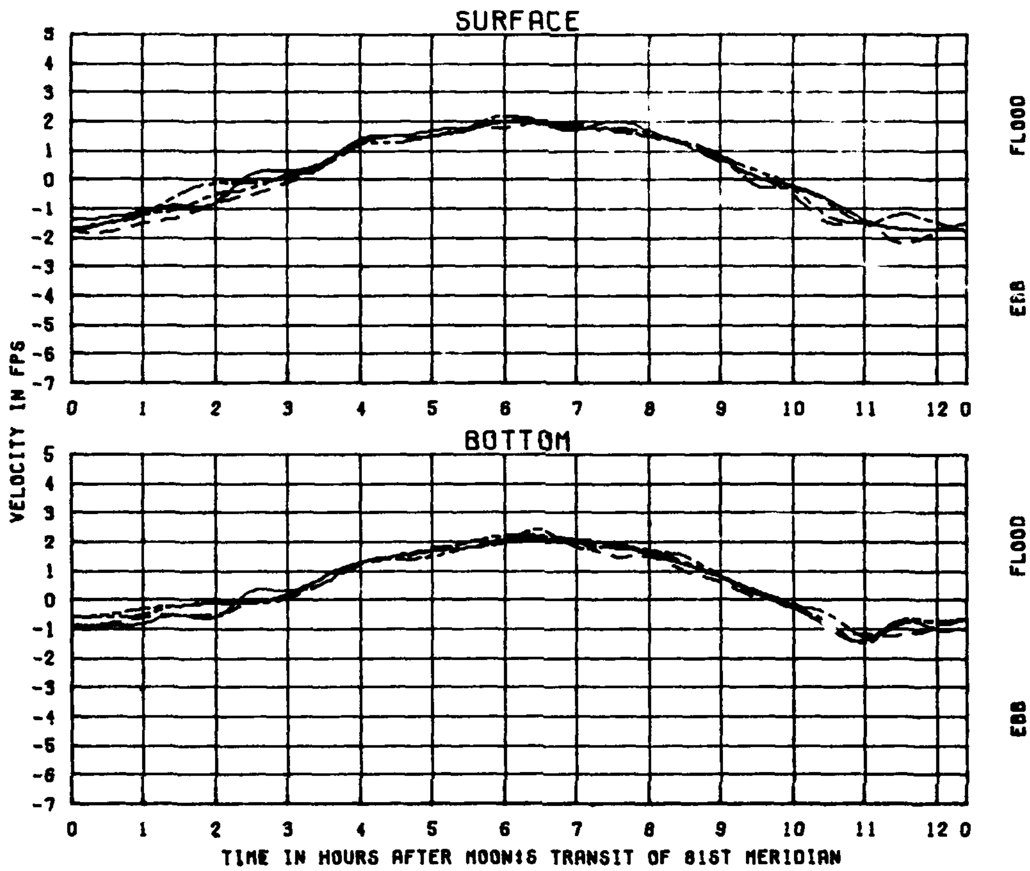
LEGEND

BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON TIDAL HEIGHTS

STATION
10

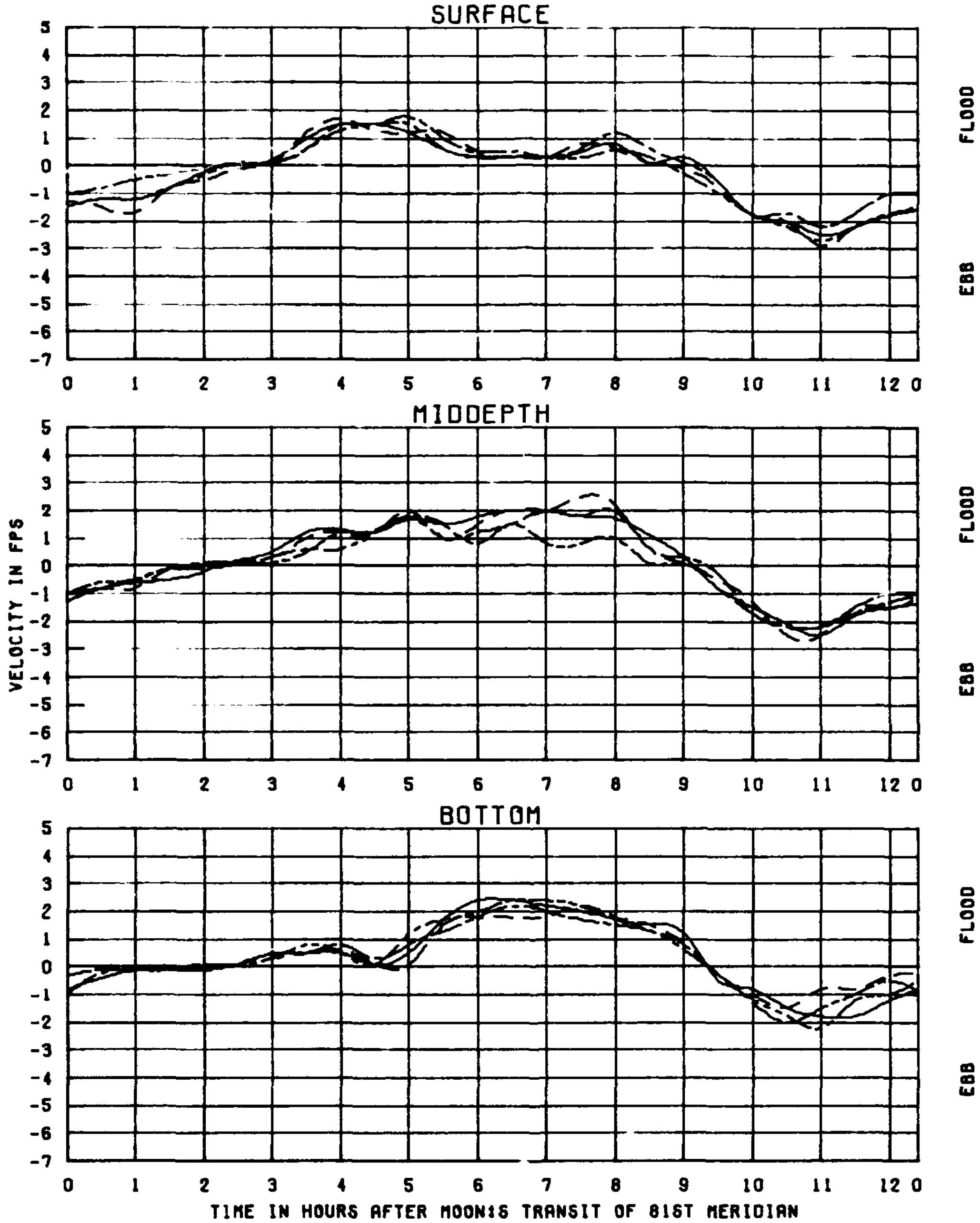


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —-·—
PLAN 4 —··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
20



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT	
OCEAN SALINITY(TOTAL SALT)	32.5 PPT	
FRESHWATER INFLOW	1100 CFS	

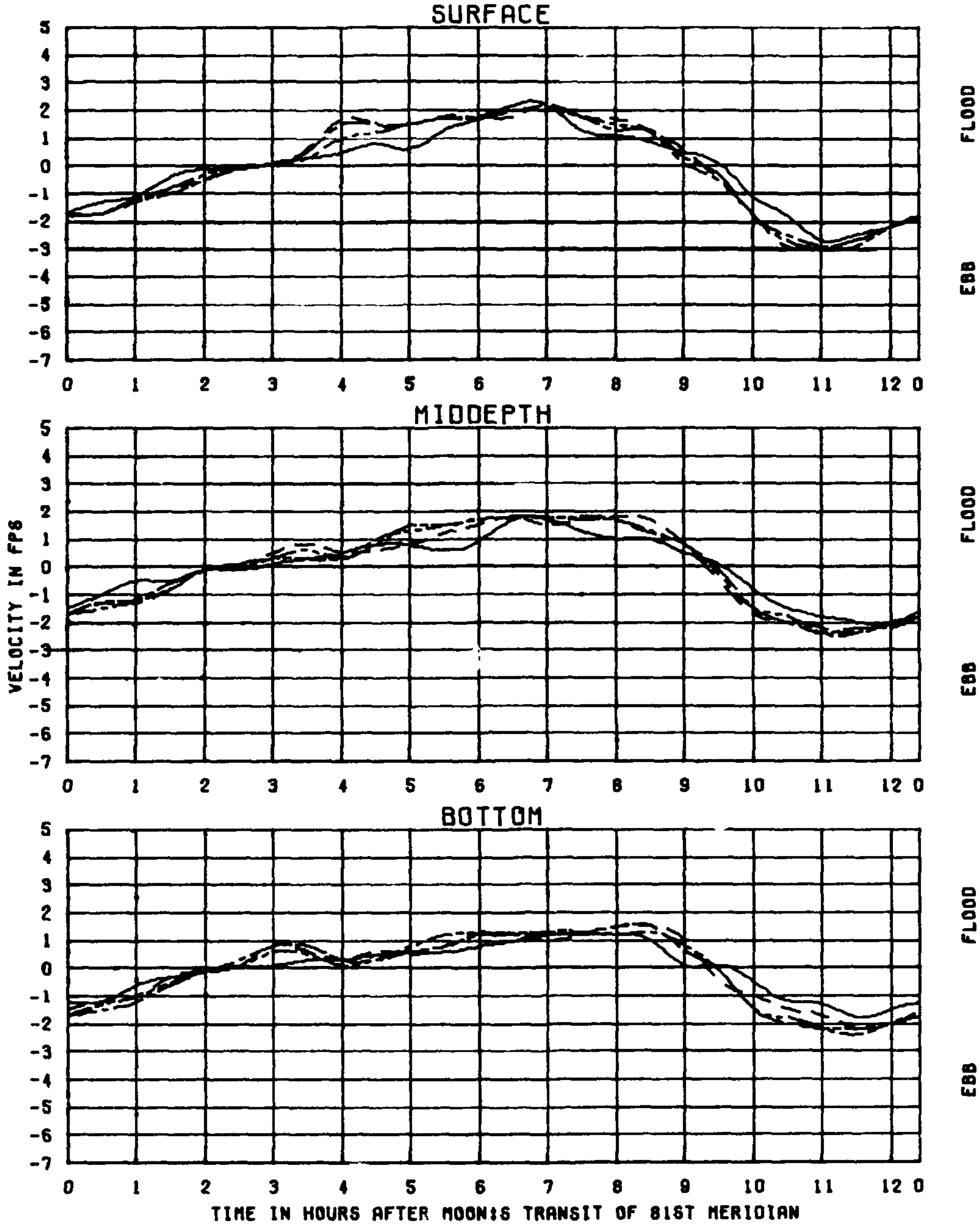
LEGEND

BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ----—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 50

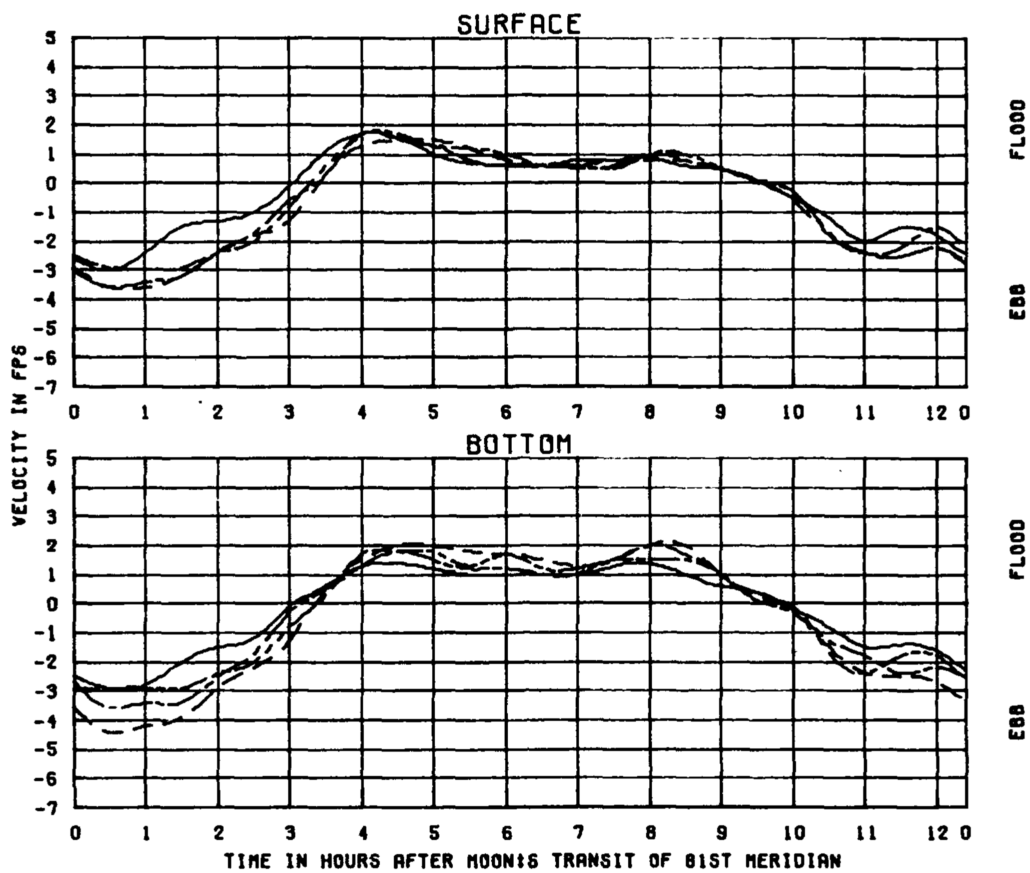


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 -----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
60

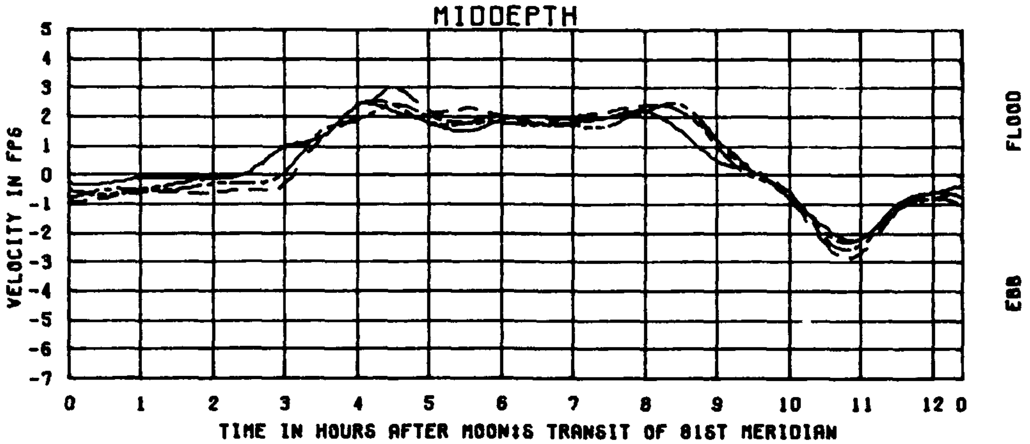


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE
PLAN 2
PLAN 3
PLAN 4

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
160



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

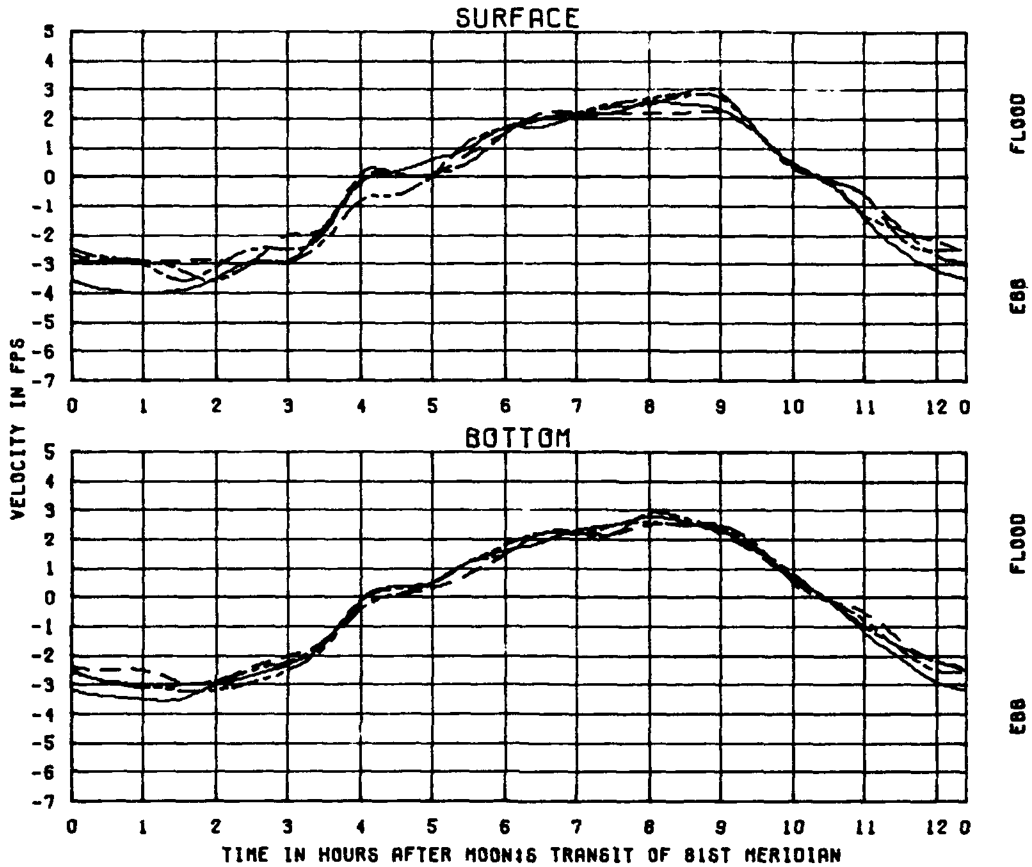
LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —-—
PLAN 4 —---—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 180



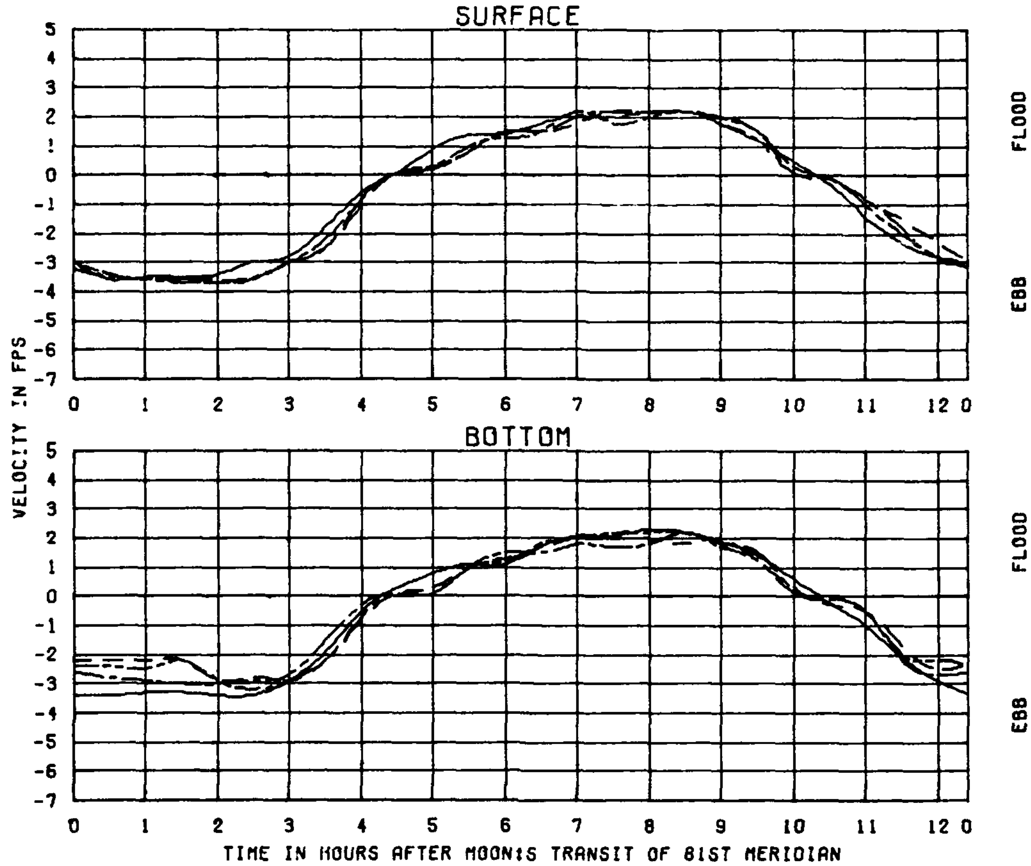
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2,P4-3,AND P4-4
ON VELOCITIES

STATION
230

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —-—
PLAN 4 —--—



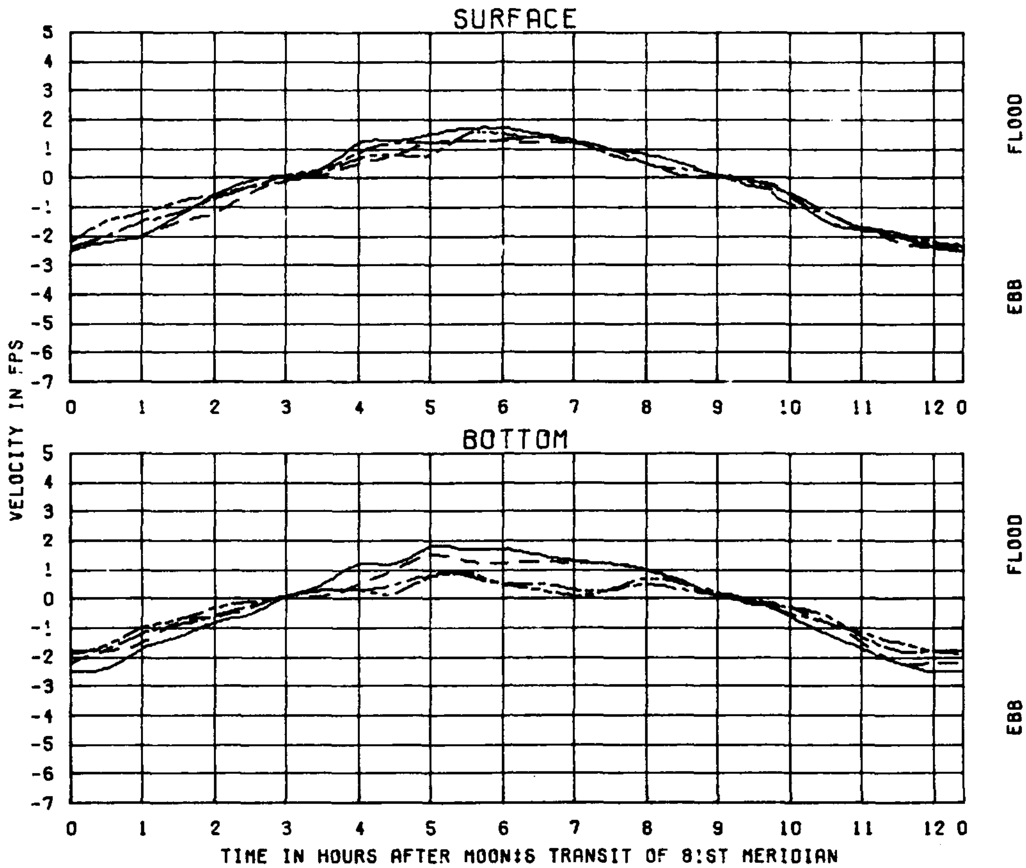
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 240

LEGEND
BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —----



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———

PLAN 2 — — —

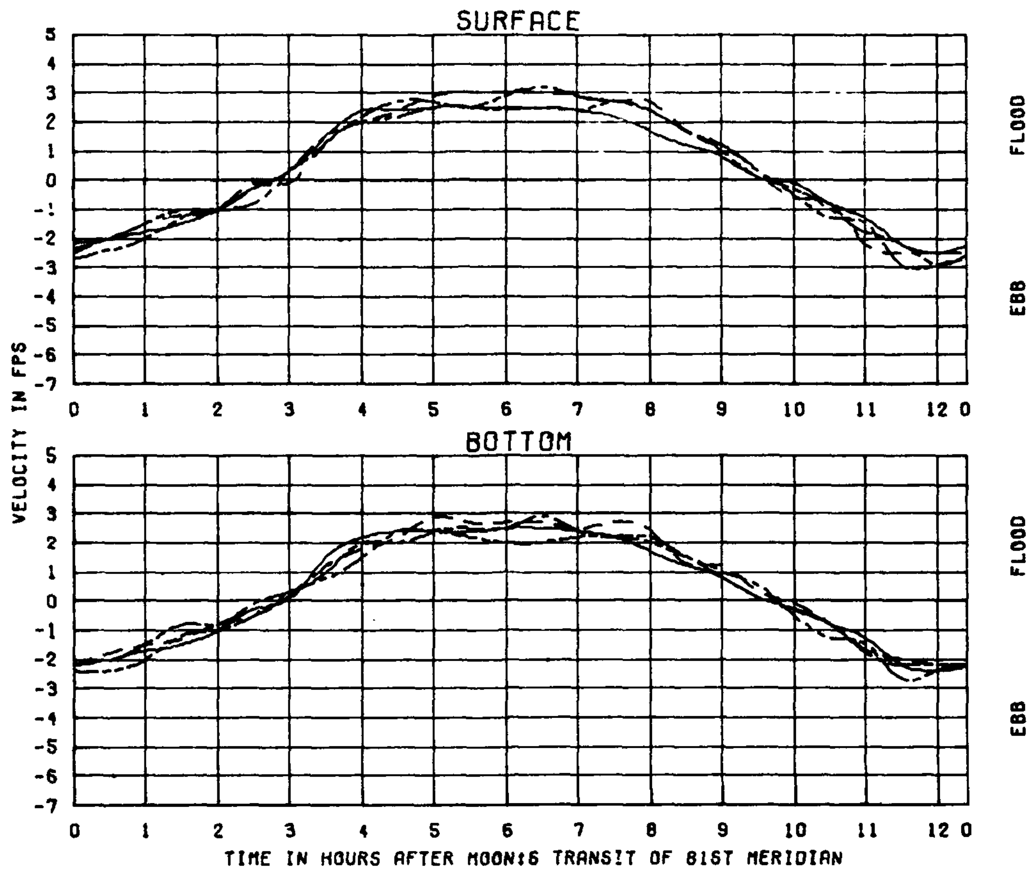
PLAN 3 —·—

PLAN 4 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 396



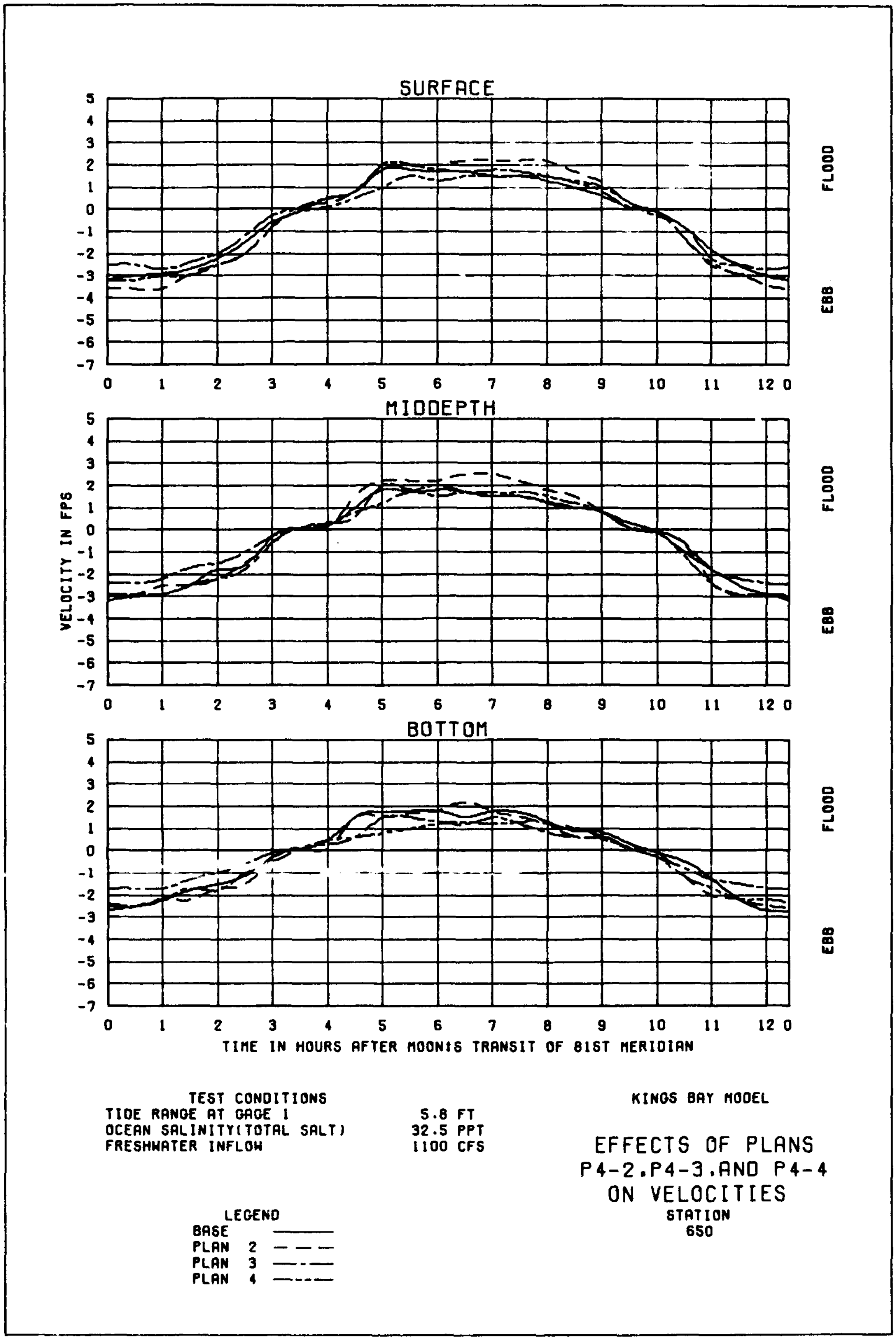
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

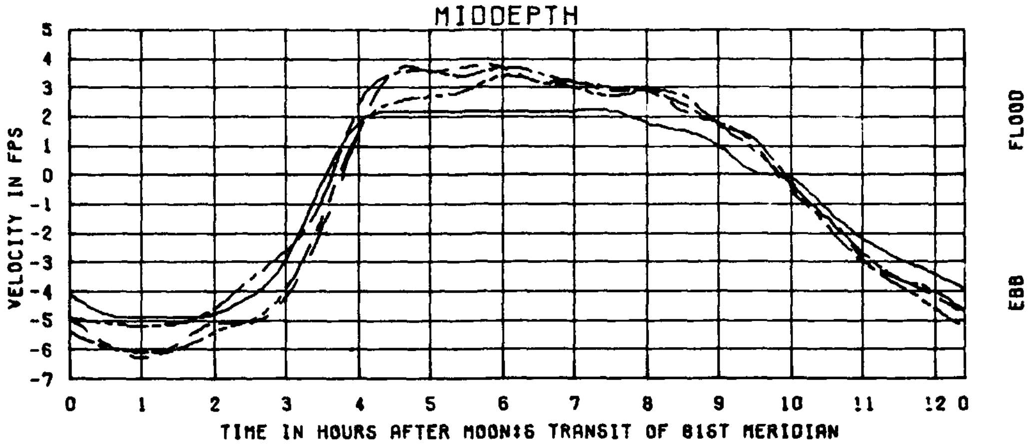
LEGEND
BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ——-——

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 584


SURFACE
MIDDEPTH
BOTTOM
VELOCITY IN FPS
FLOOD
EBB
TIME IN HOURS AFTER MOON'S TRANSIT OF 81ST MERIDIAN
TEST CONDITIONS
TIDE RANGE AT GAGE 1 5.8 FT
OCEAN SALINITY(TOTAL SALT) 32.5 PPT
FRESHWATER INFLOW 1100 CFS
KINGS BAY MODEL
EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES
STATION 650
LEGEND
BASE
PLAN 2
PLAN 3
PLAN 4



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

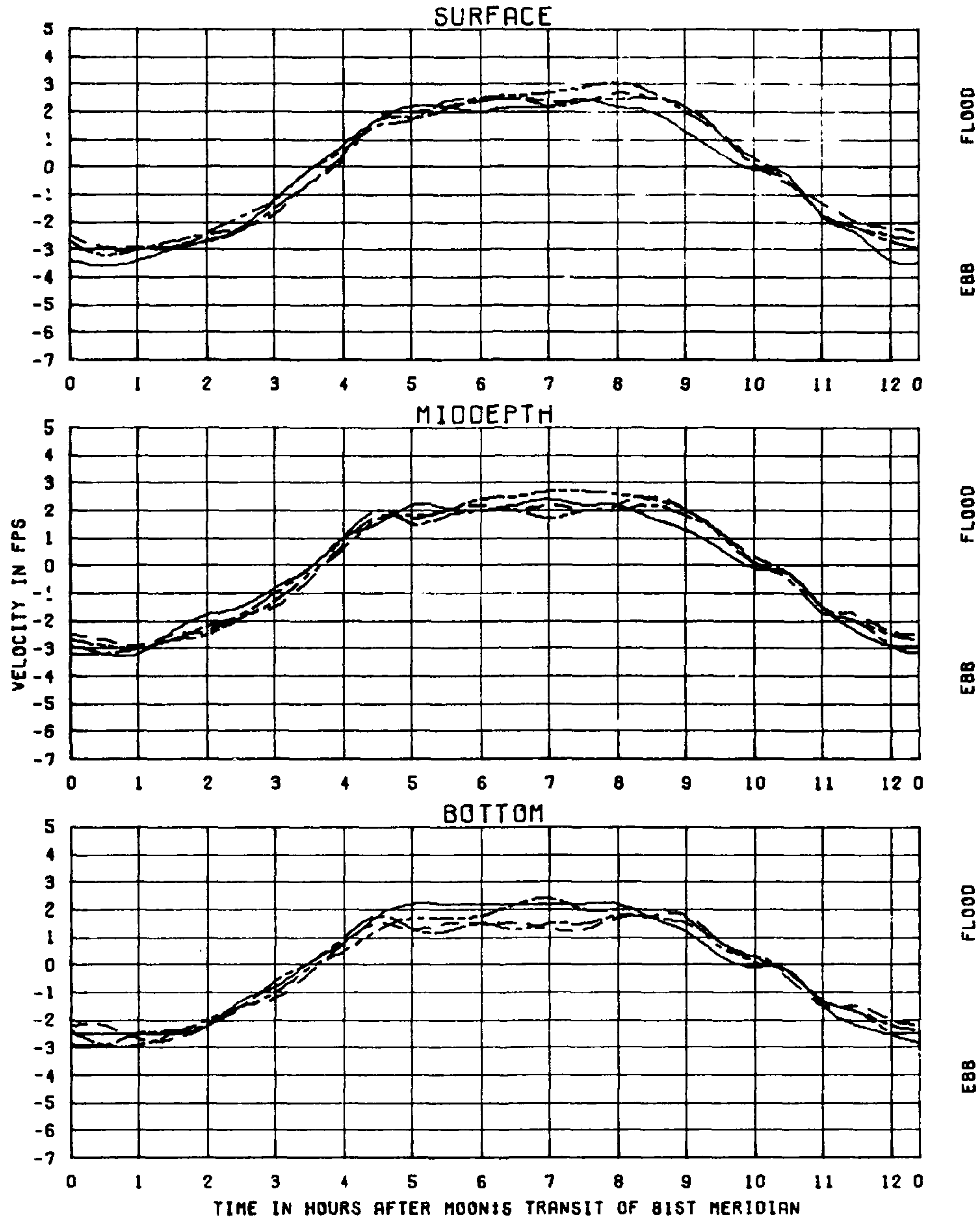
LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —-—-—
PLAN 4 —--—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 812



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

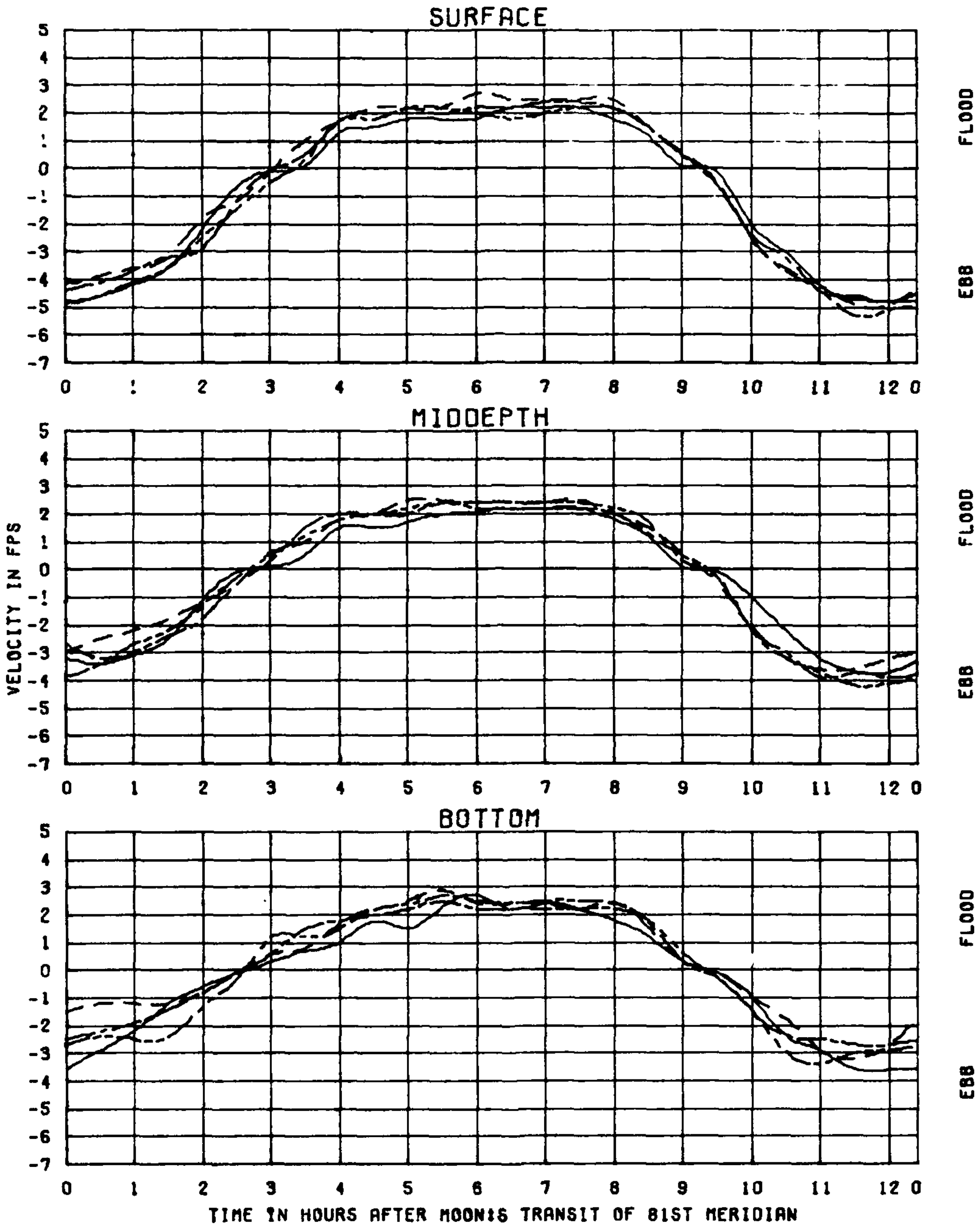
LEGEND

BASE	————
PLAN 2	— — —
PLAN 3	—·—·—
PLAN 4	—··—··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 818



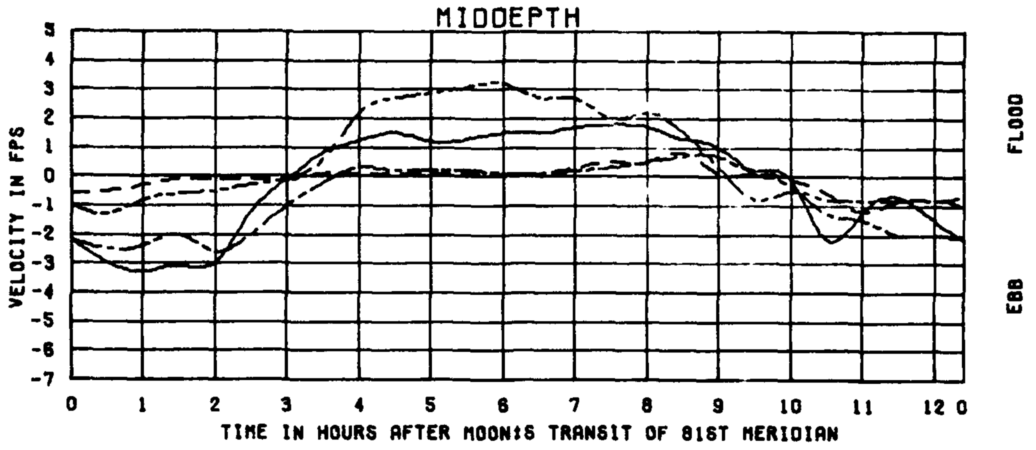
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ---—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 843



TEST CONDITIONS

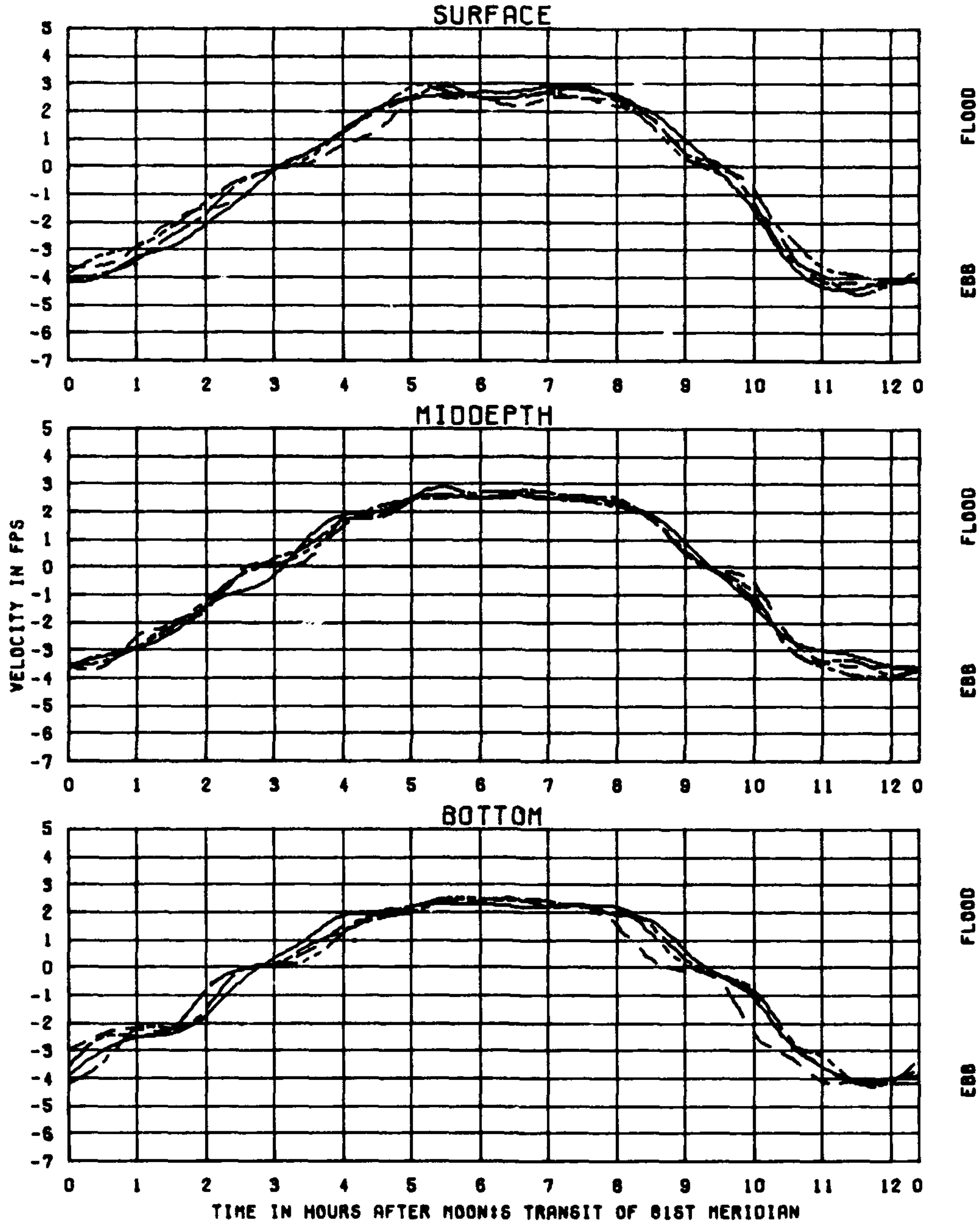
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1014

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ---—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

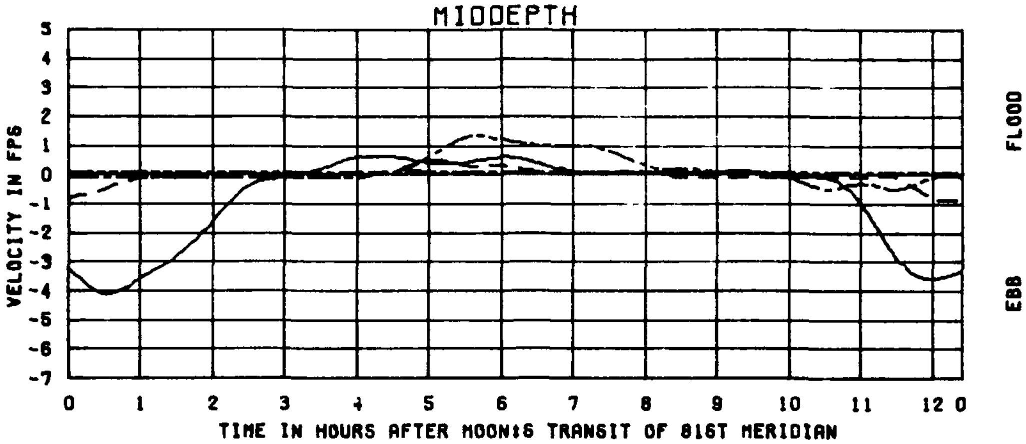
LEGEND

BASE	———
PLAN 2	— — —
PLAN 3	—·—·—
PLAN 4	—··—··

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1055



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

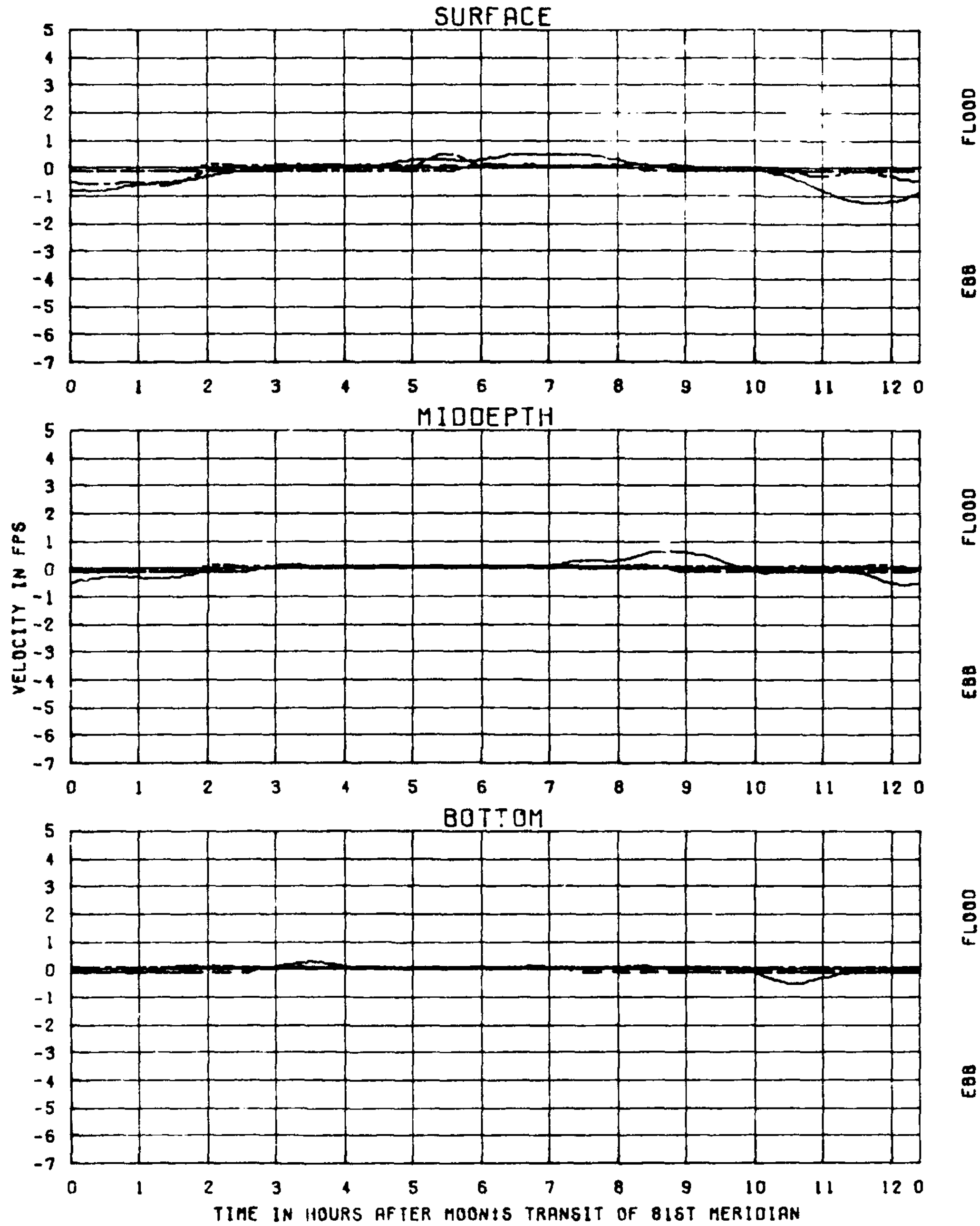
LEGEND

- BASE ————
- PLAN 2 — — —
- PLAN 3 —·—
- PLAN 4 —-—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1066



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

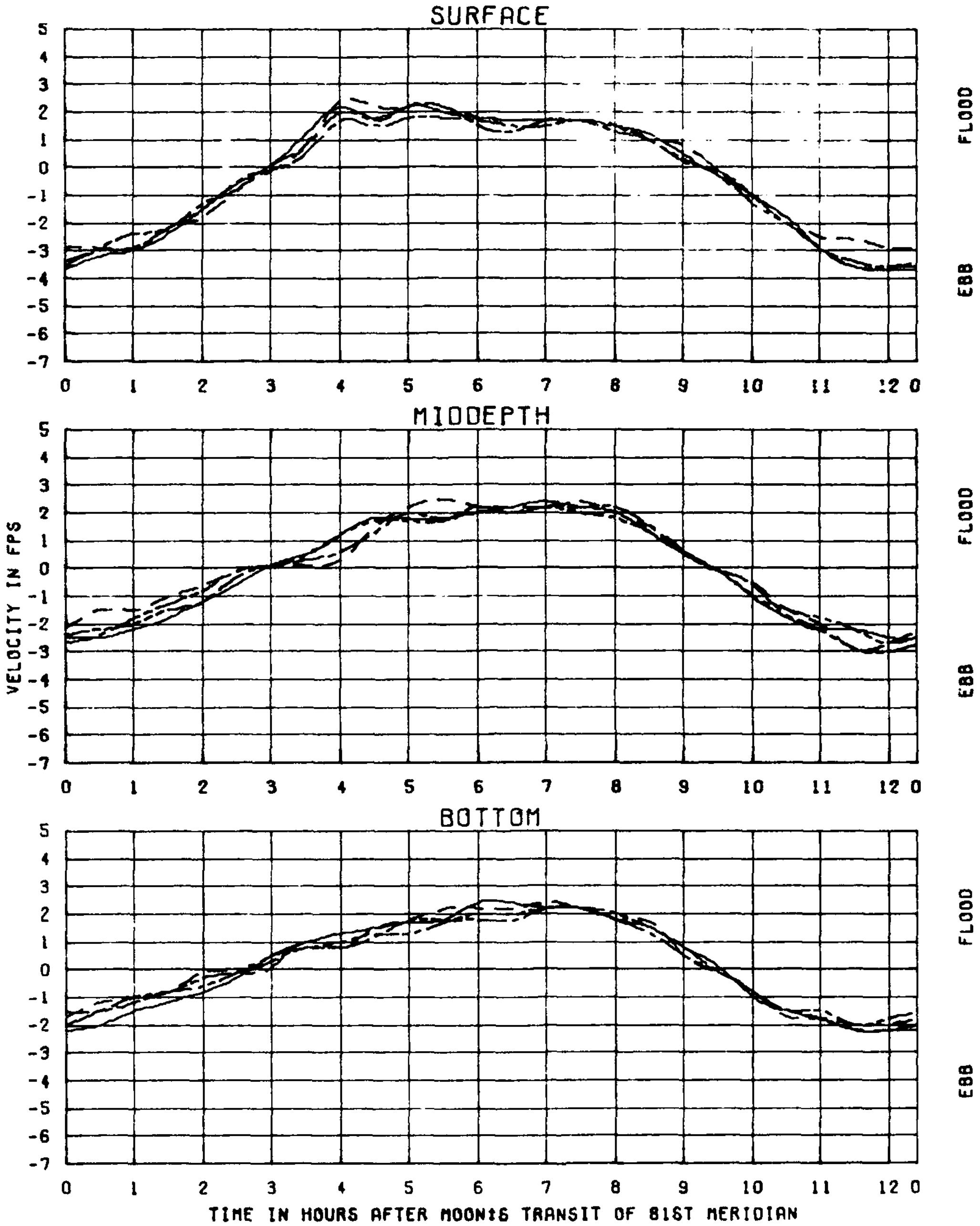
LEGEND

BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —·-·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES

STATION
1142

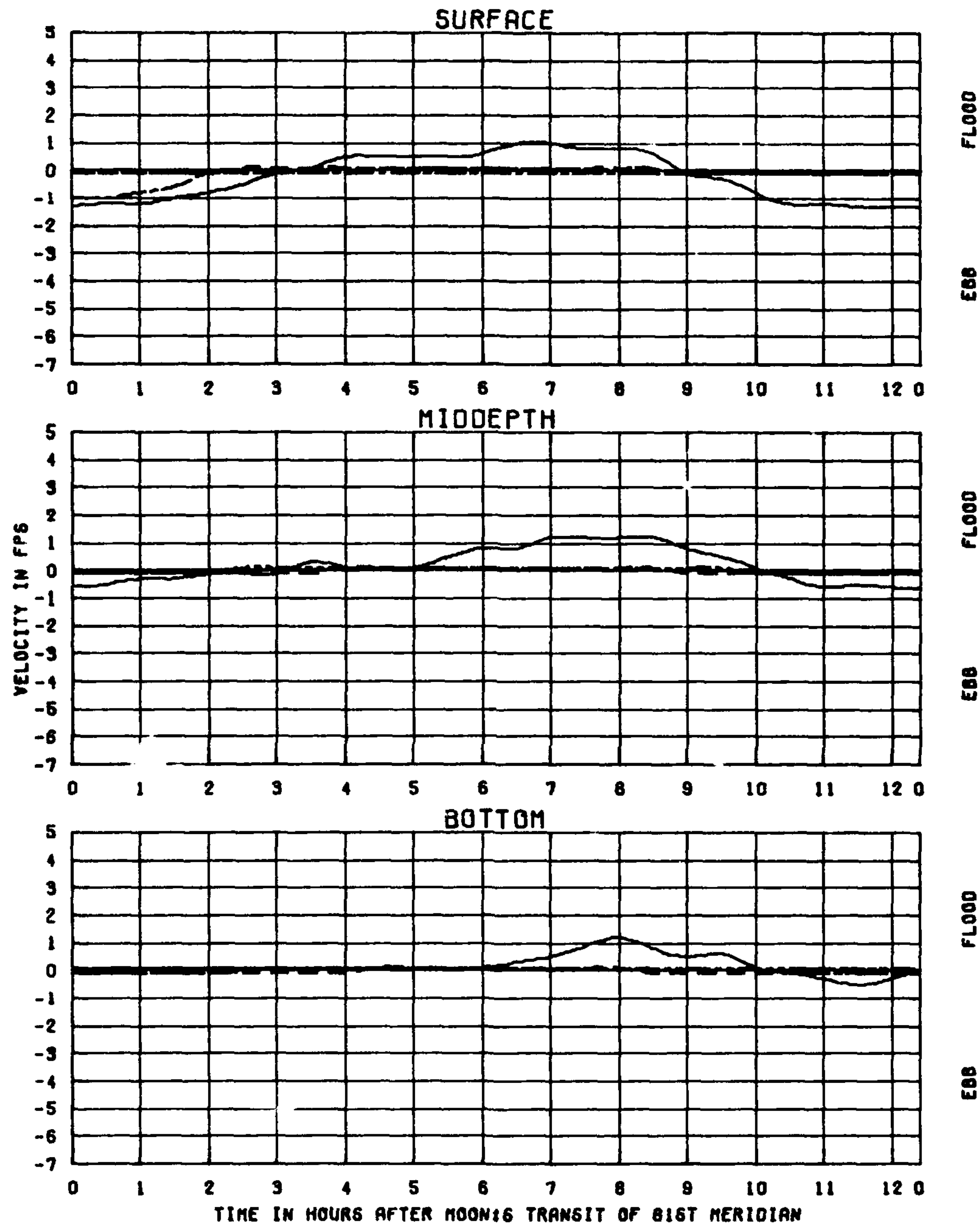


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
1153

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ----—

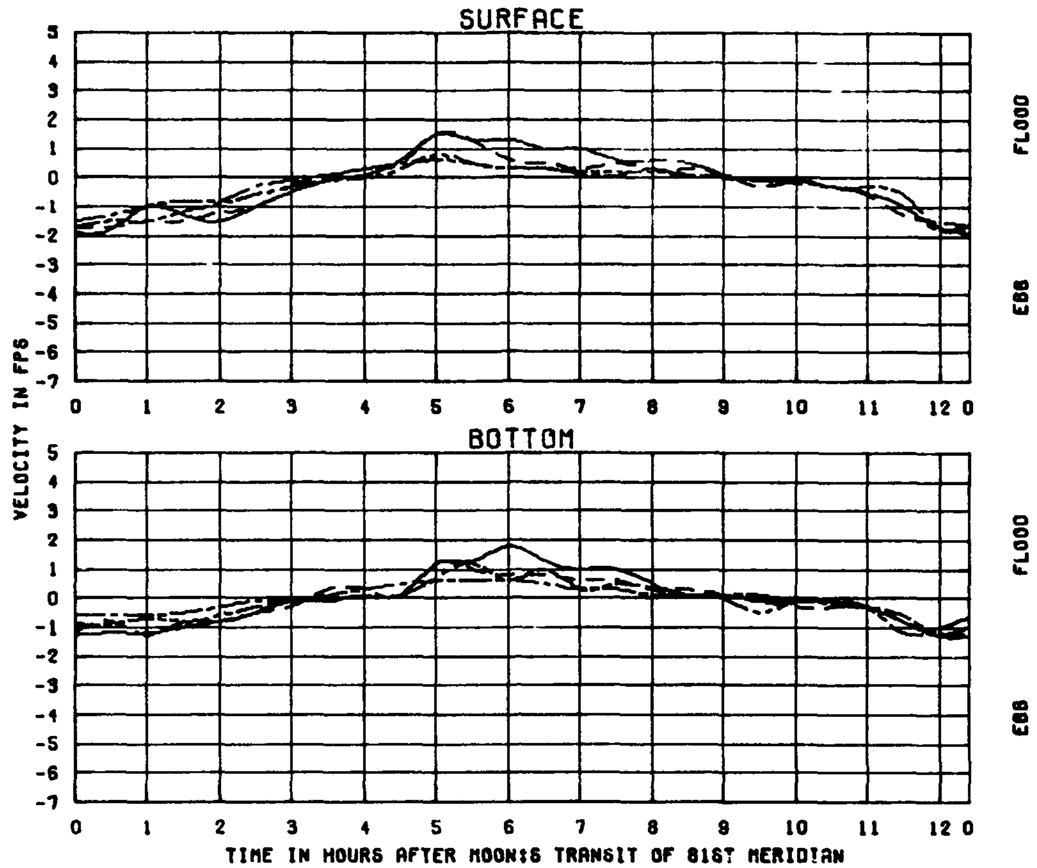


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
1182

LEGEND
BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —··—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

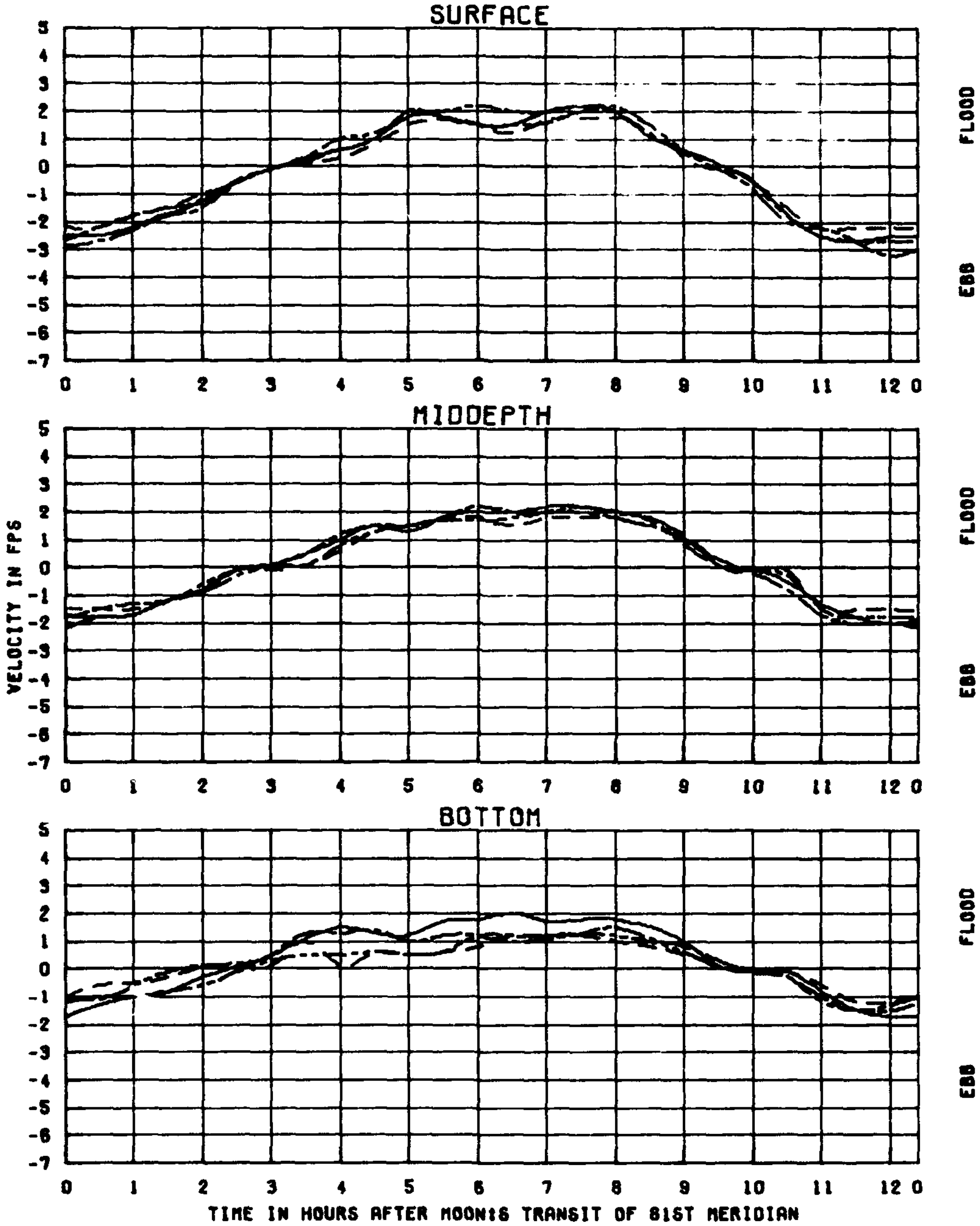
LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —·-·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES

STATION
1276



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

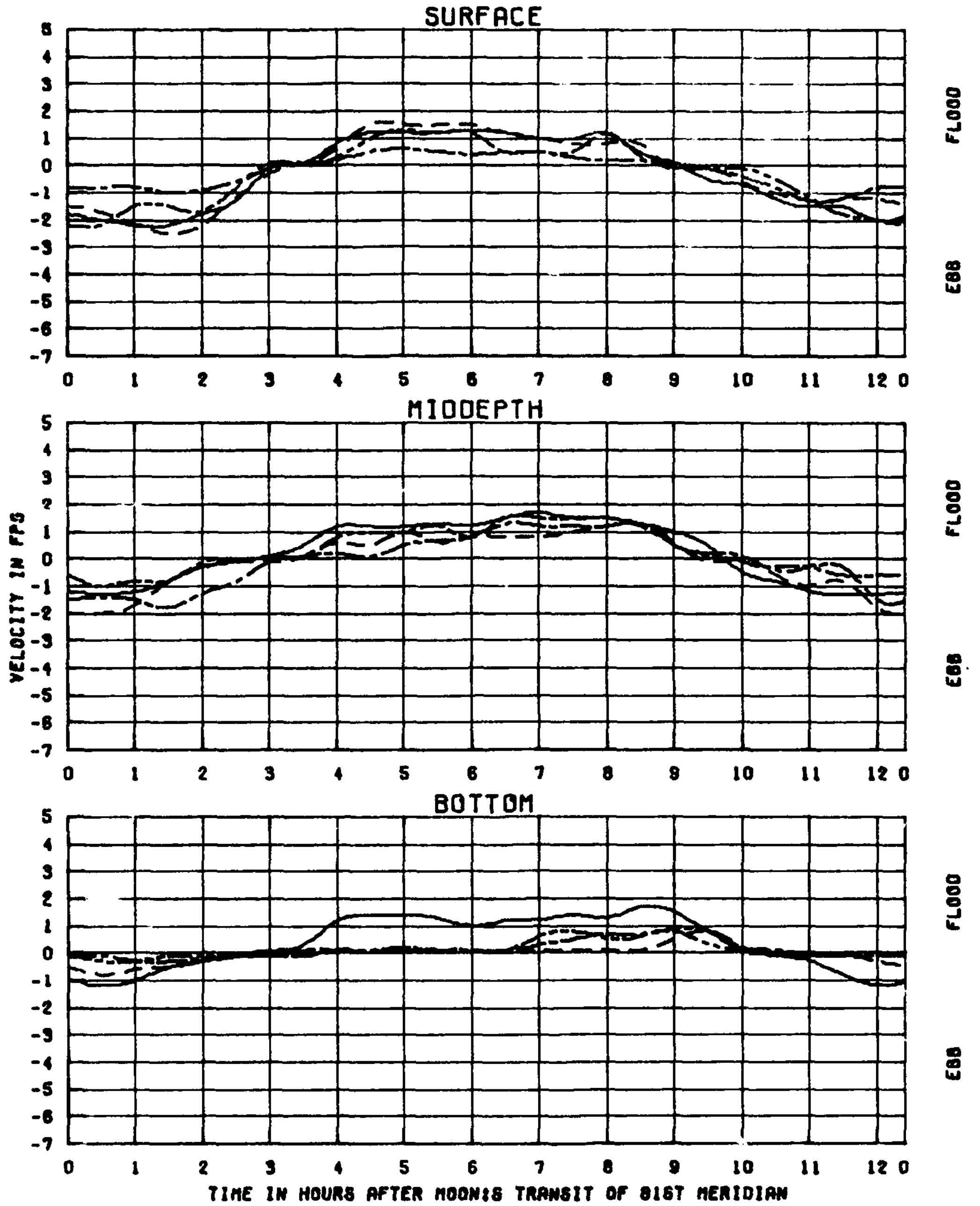
LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —·—·—
PLAN 4 -·-·-·-

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1385



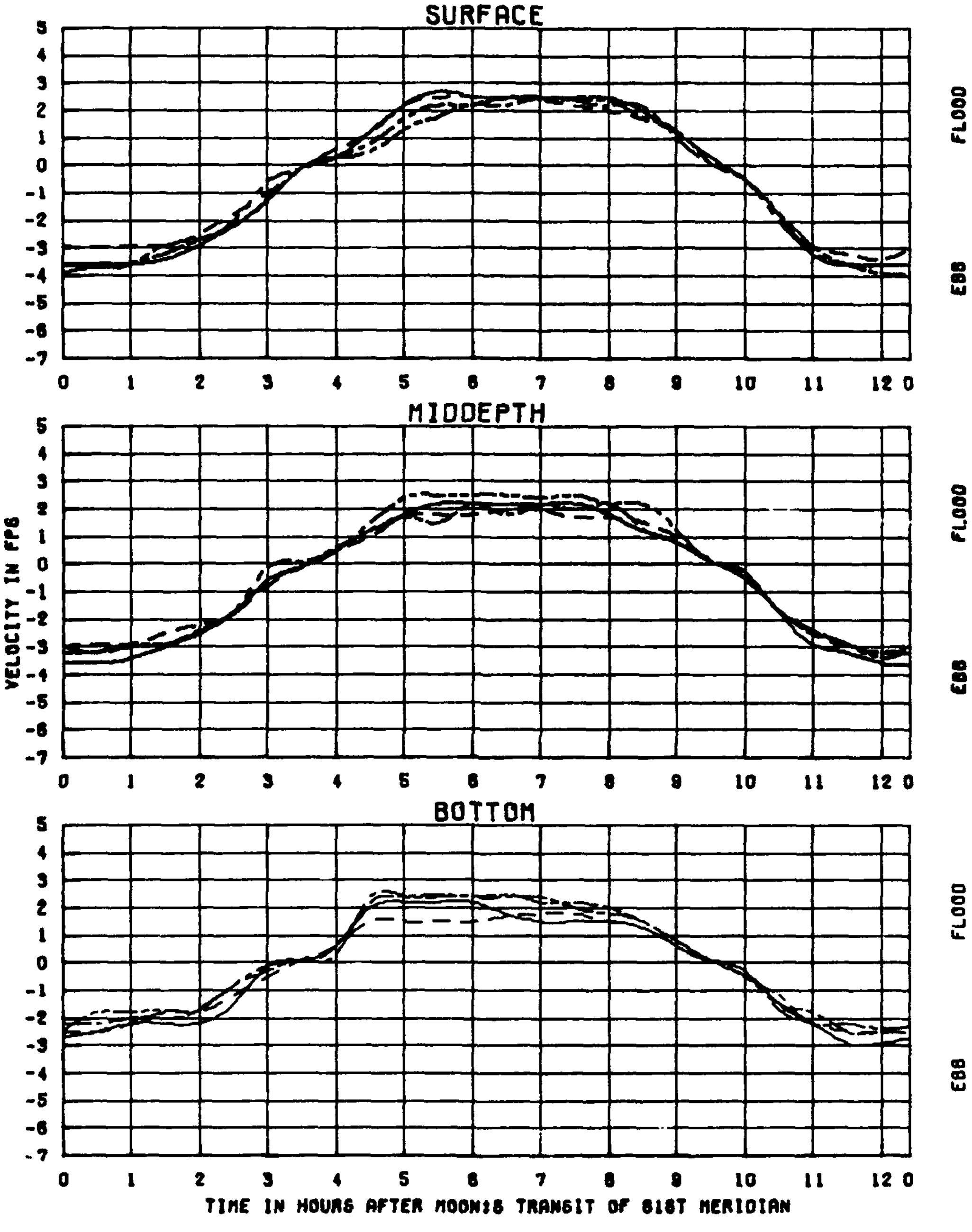
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—·—
PLAN 4 —··—··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES

STATION
1851



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

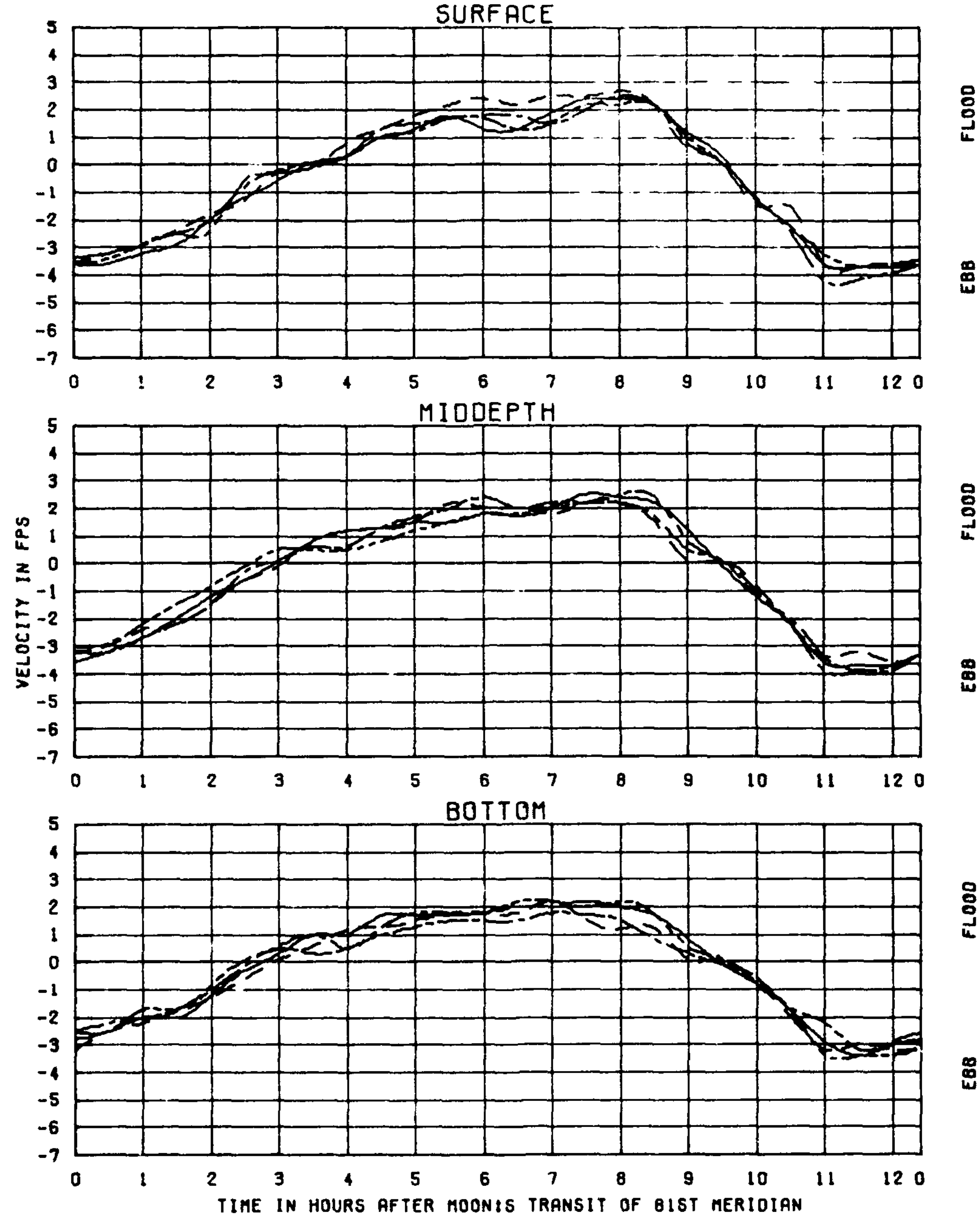
LEGEND

BASE
PLAN 2
PLAN 3
PLAN 4

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1865



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

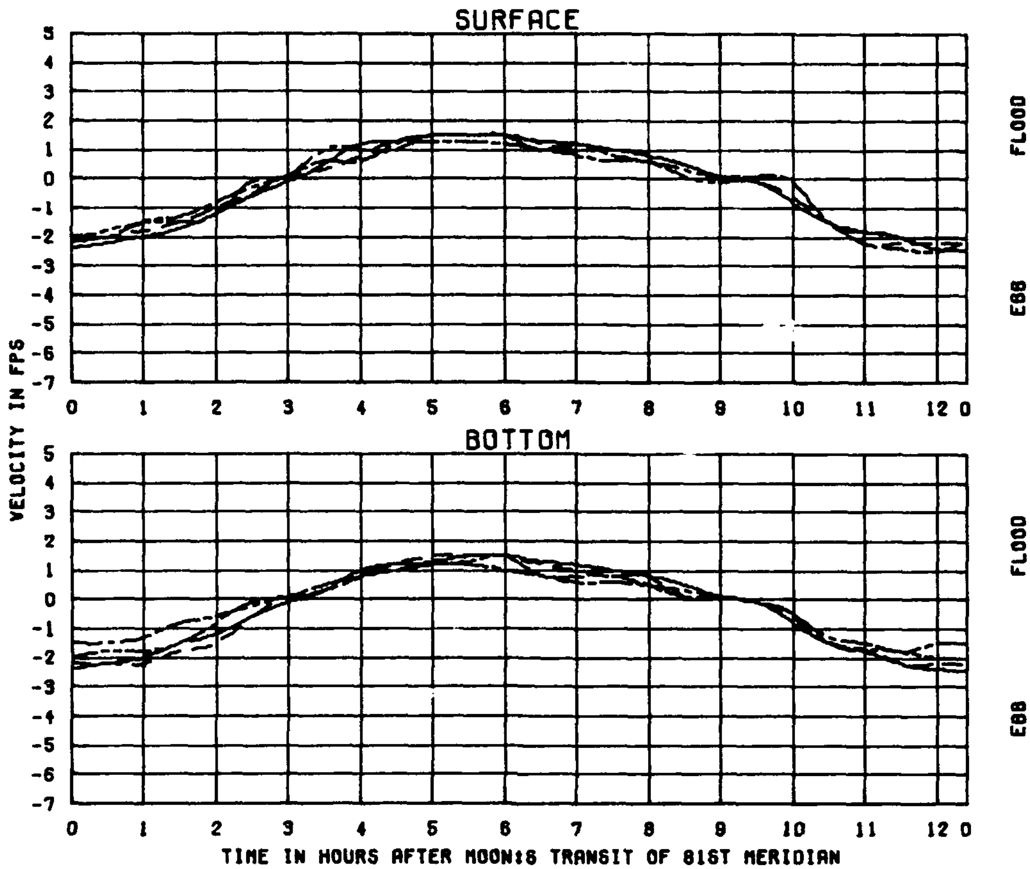
LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —-·-—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1869



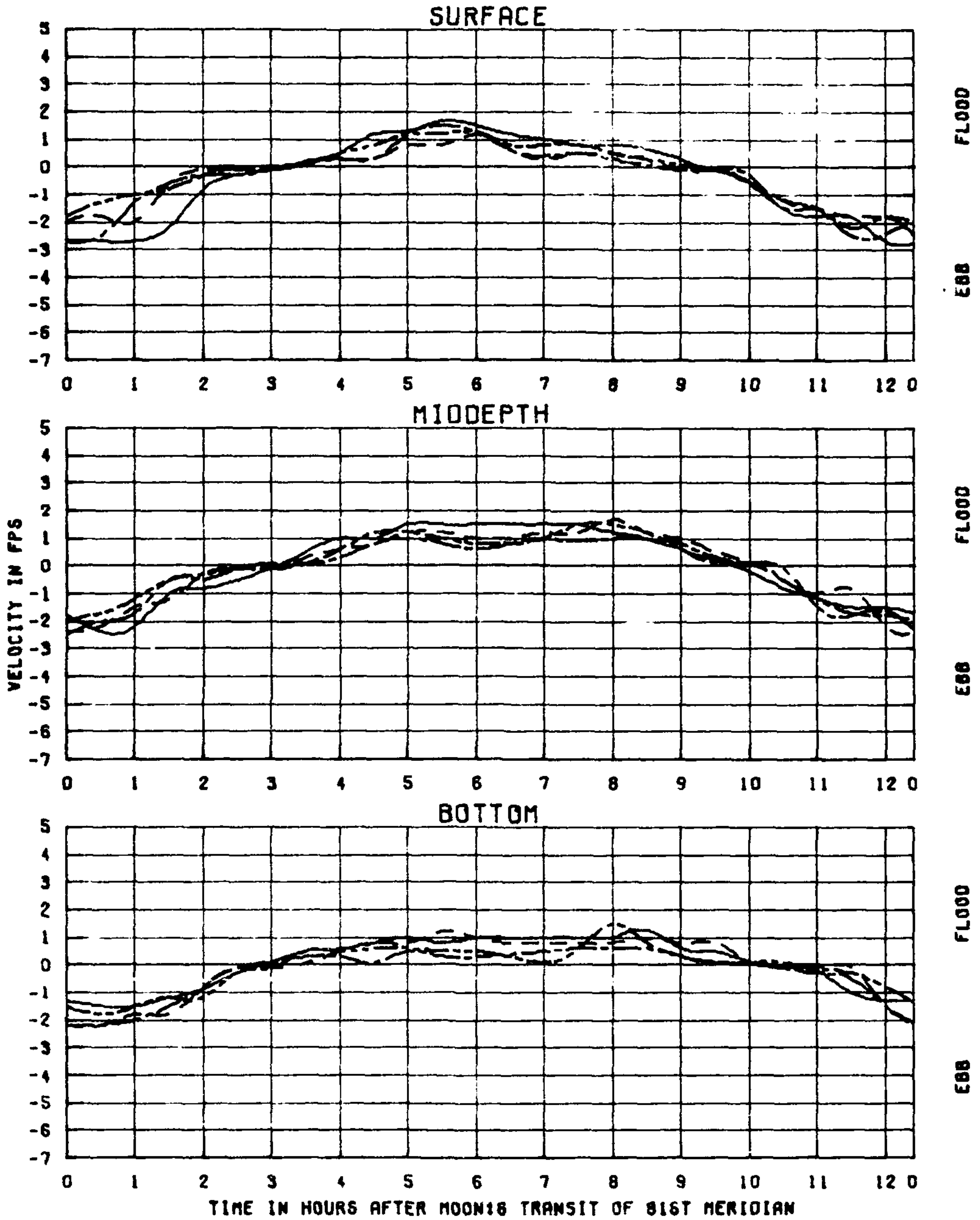
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ——-—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2,P4-3,AND P4-4
ON VELOCITIES
STATION
1883

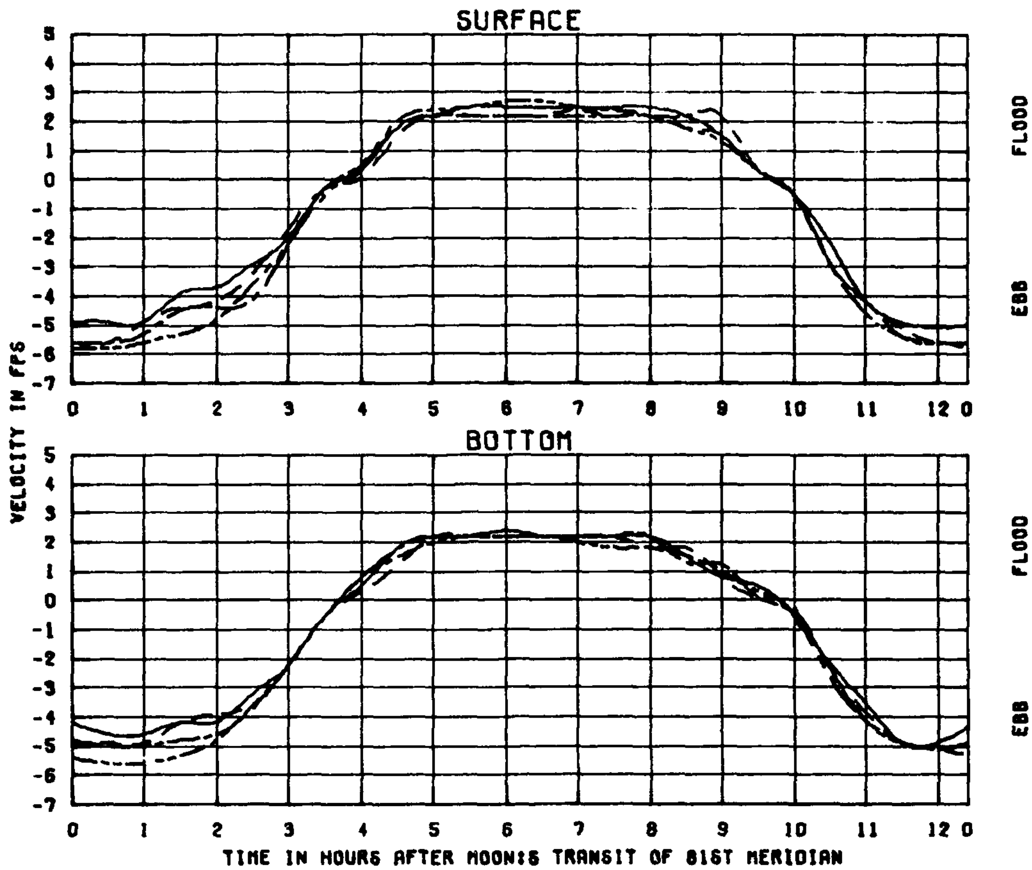


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 1915



TEST CONDITIONS

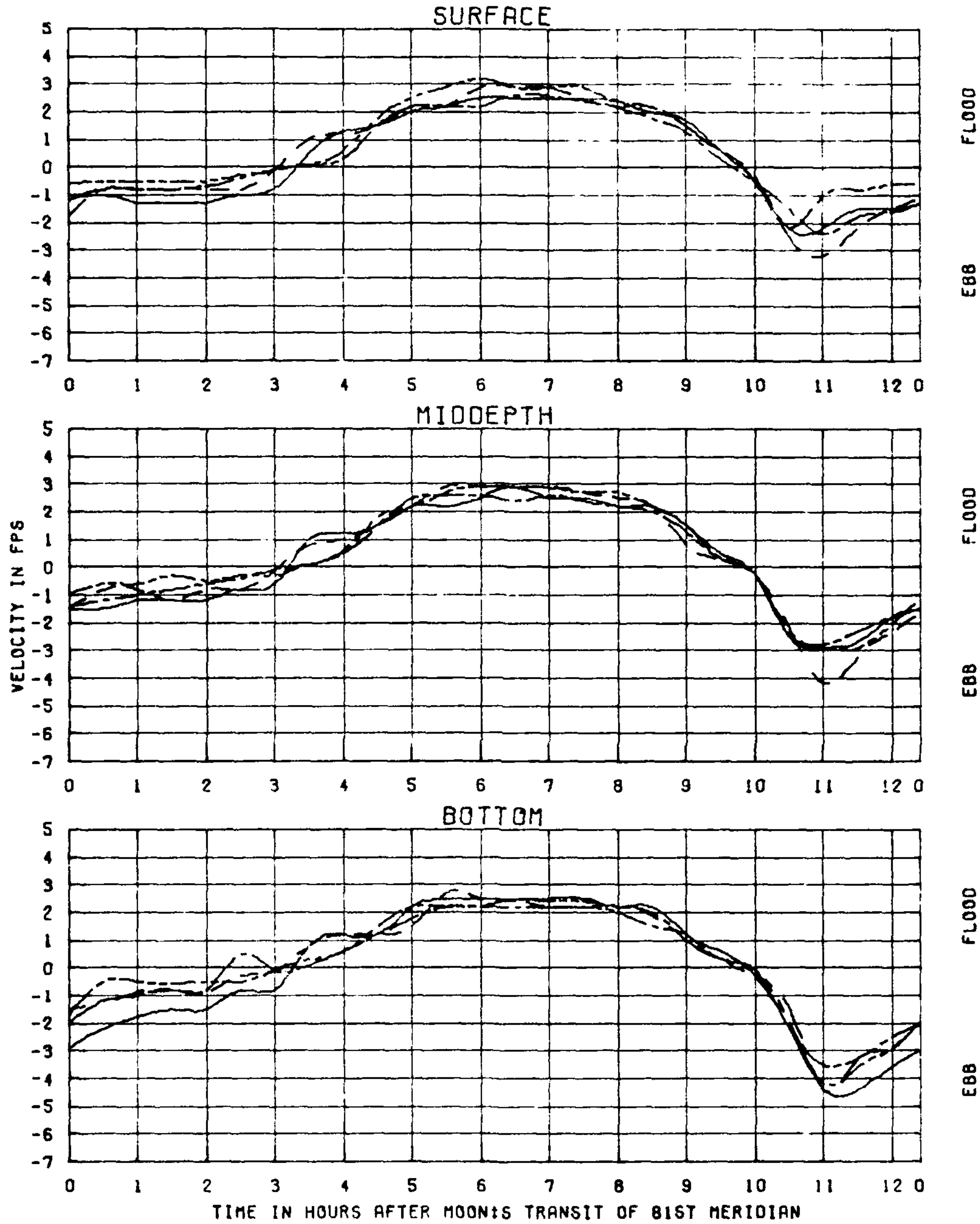
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ————
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 -·-·-

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2,P4-3,AND P4-4
ON VELOCITIES
STATION
1979



TEST CONDITIONS

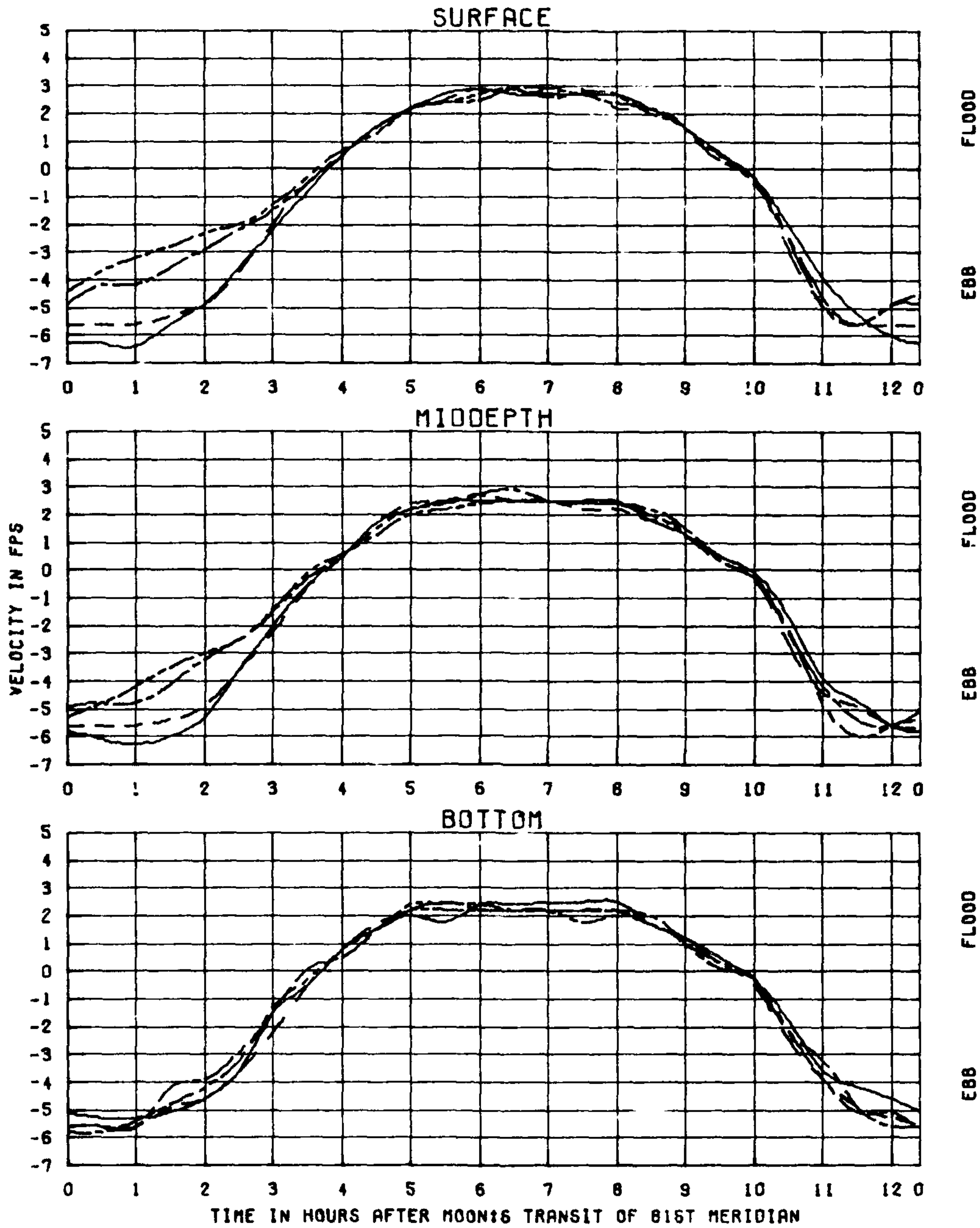
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 —·-·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2,P4-3,AND P4-4
ON VELOCITIES
STATION
1981



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

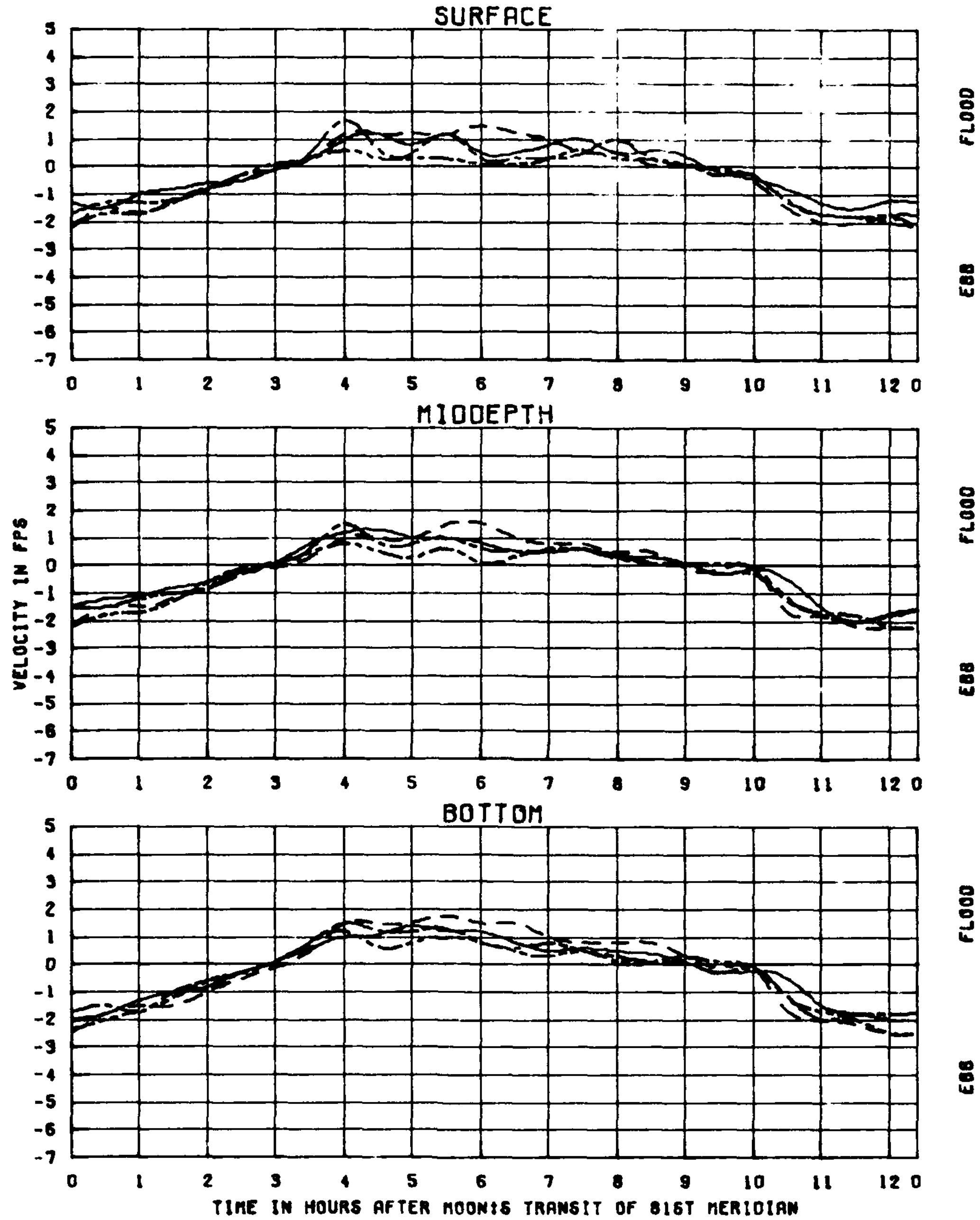
LEGEND

BASE	———
PLAN 2	— — —
PLAN 3	—·—
PLAN 4	-----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES

STATION
1989



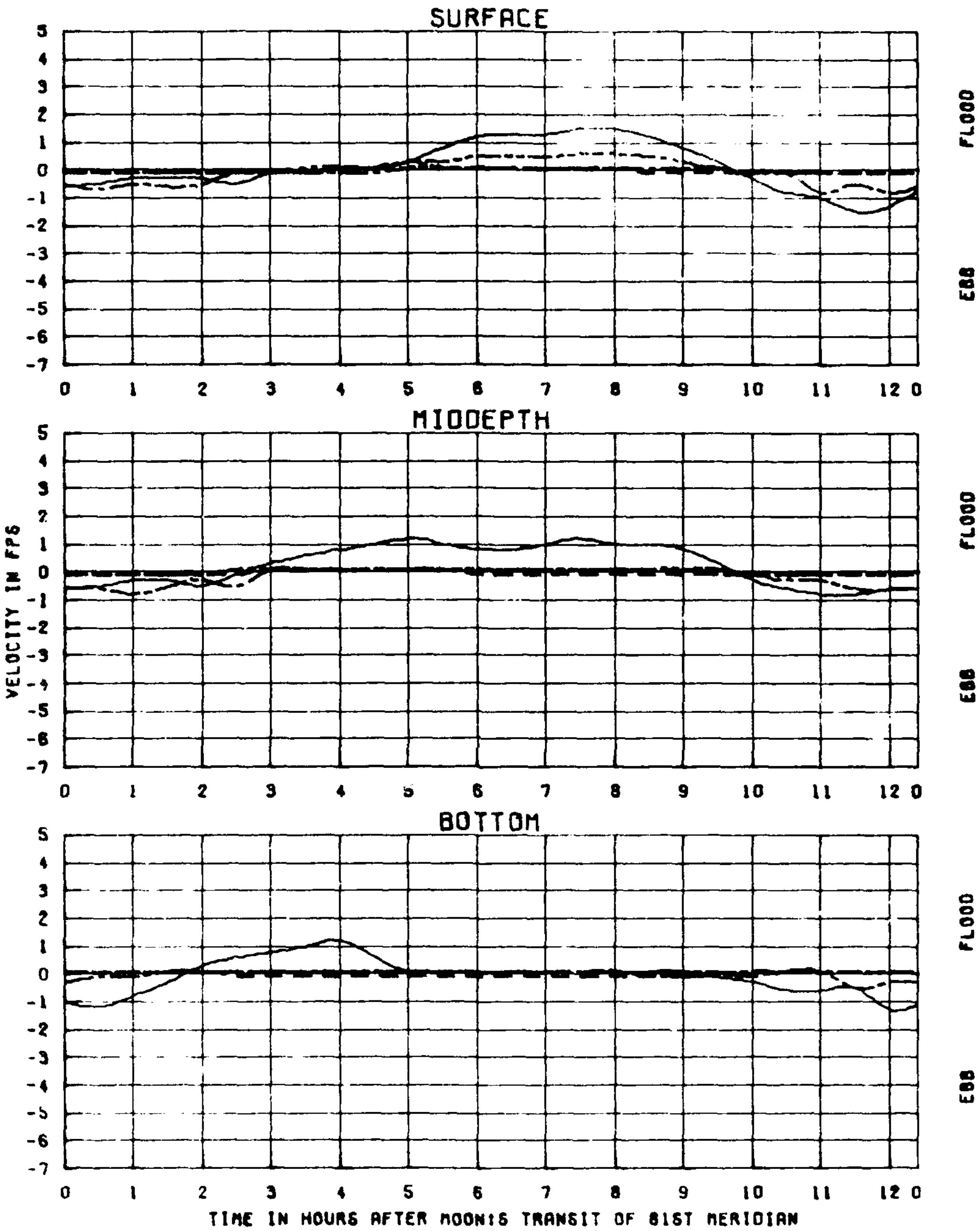
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 2 — — —
PLAN 3 —·—
PLAN 4 ----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2, P4-3, AND P4-4
ON VELOCITIES
STATION
1999



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

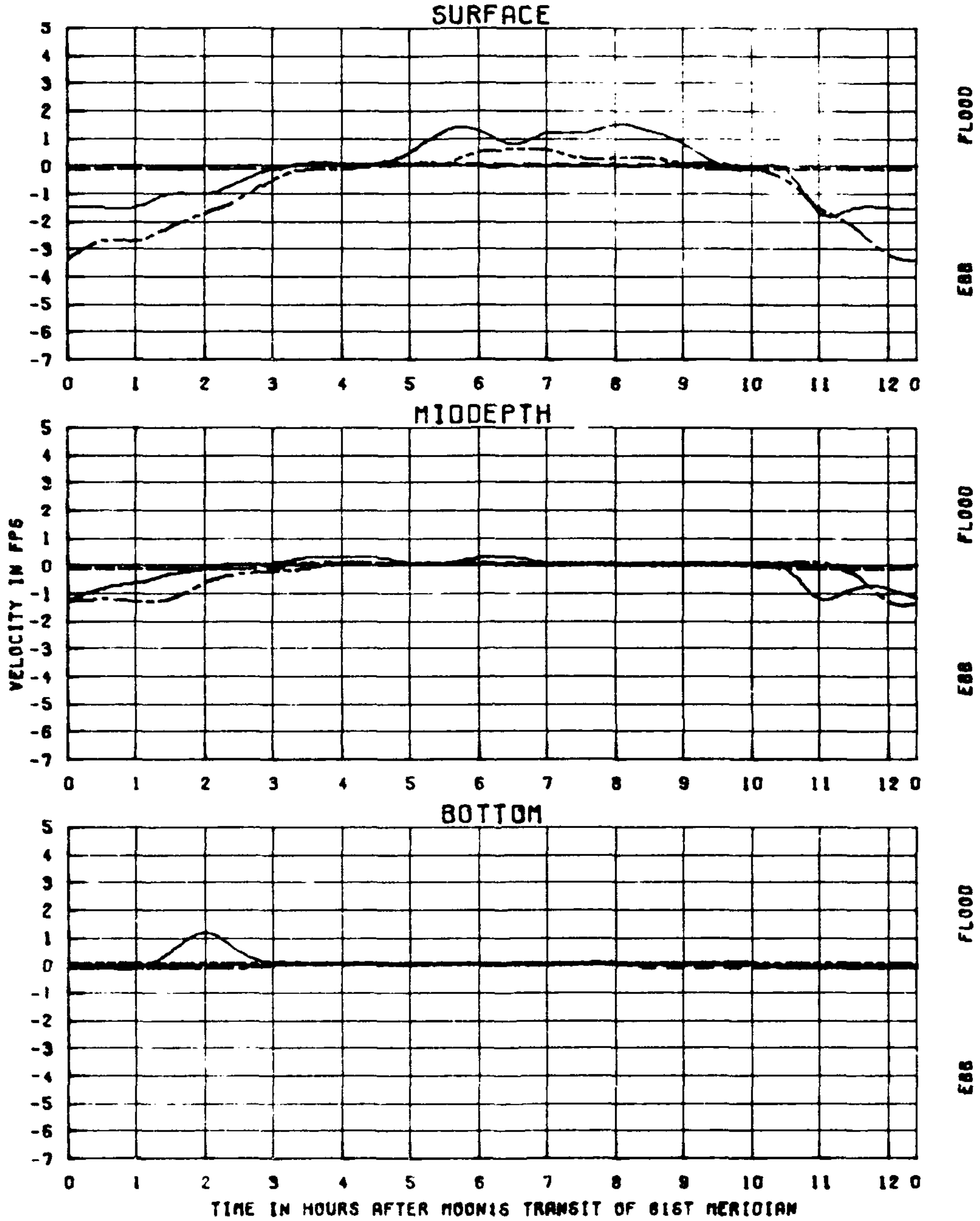
LEGEND

BASE	————
PLAN 2	— — —
PLAN 3	—·—
PLAN 4	-----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-2,P4-3,AND P4-4
ON VELOCITIES

STATION
2074



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———

PLAN 2 — — —

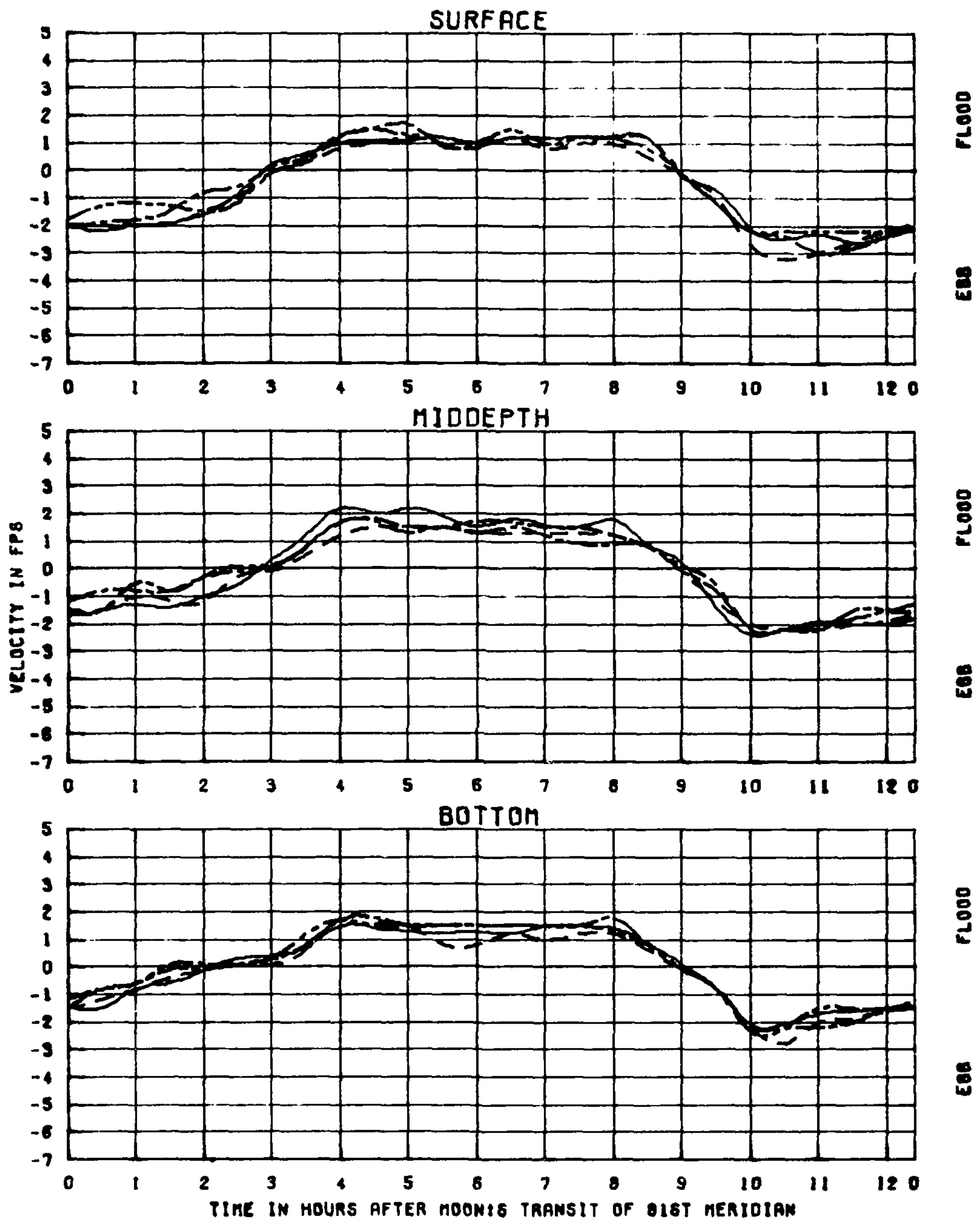
PLAN 3 — - - -

PLAN 4 —-—-—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 2089



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

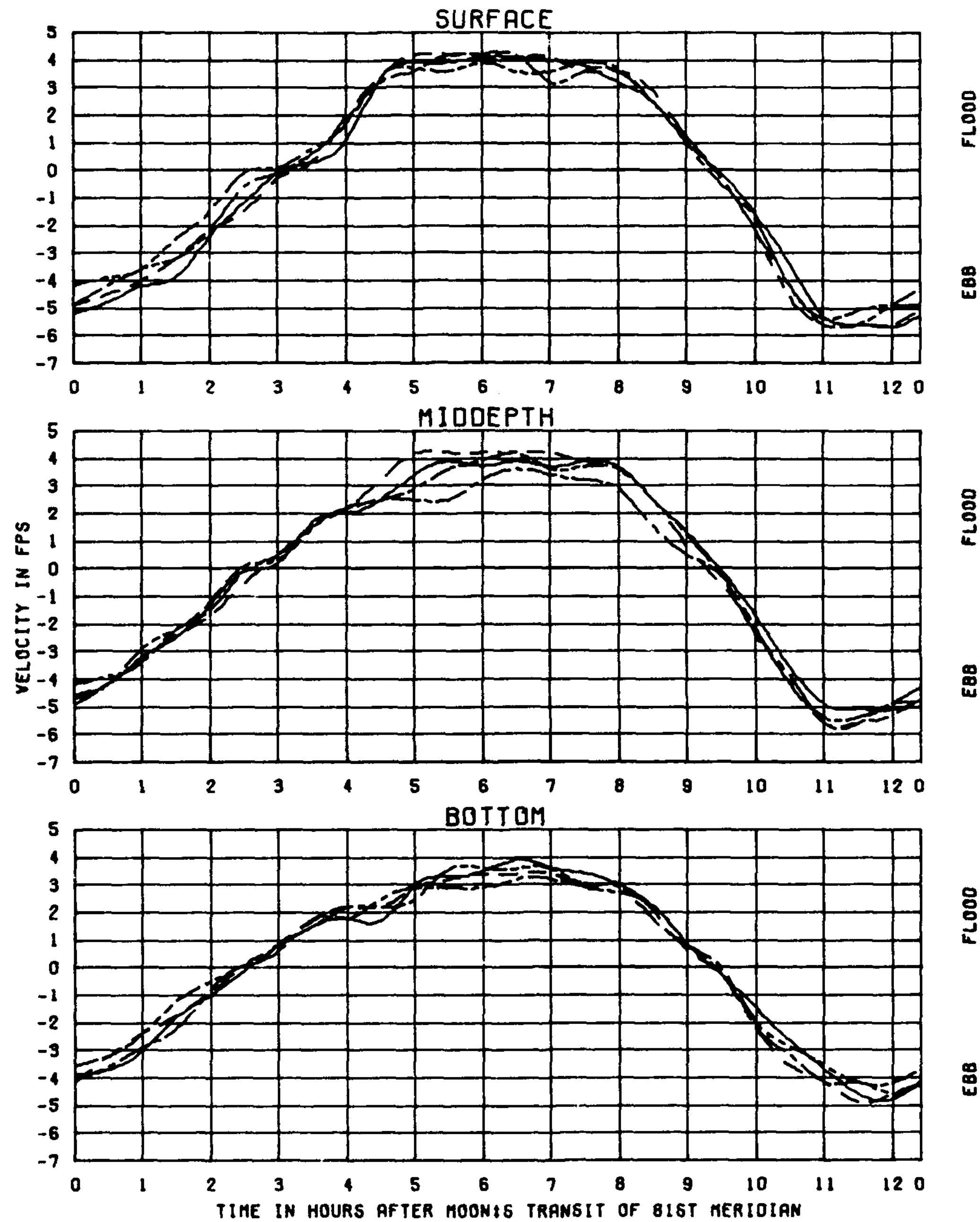
BASE	———
PLAN 2	— — —
PLAN 3	—-·-—
PLAN 4	—---—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION

2120



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

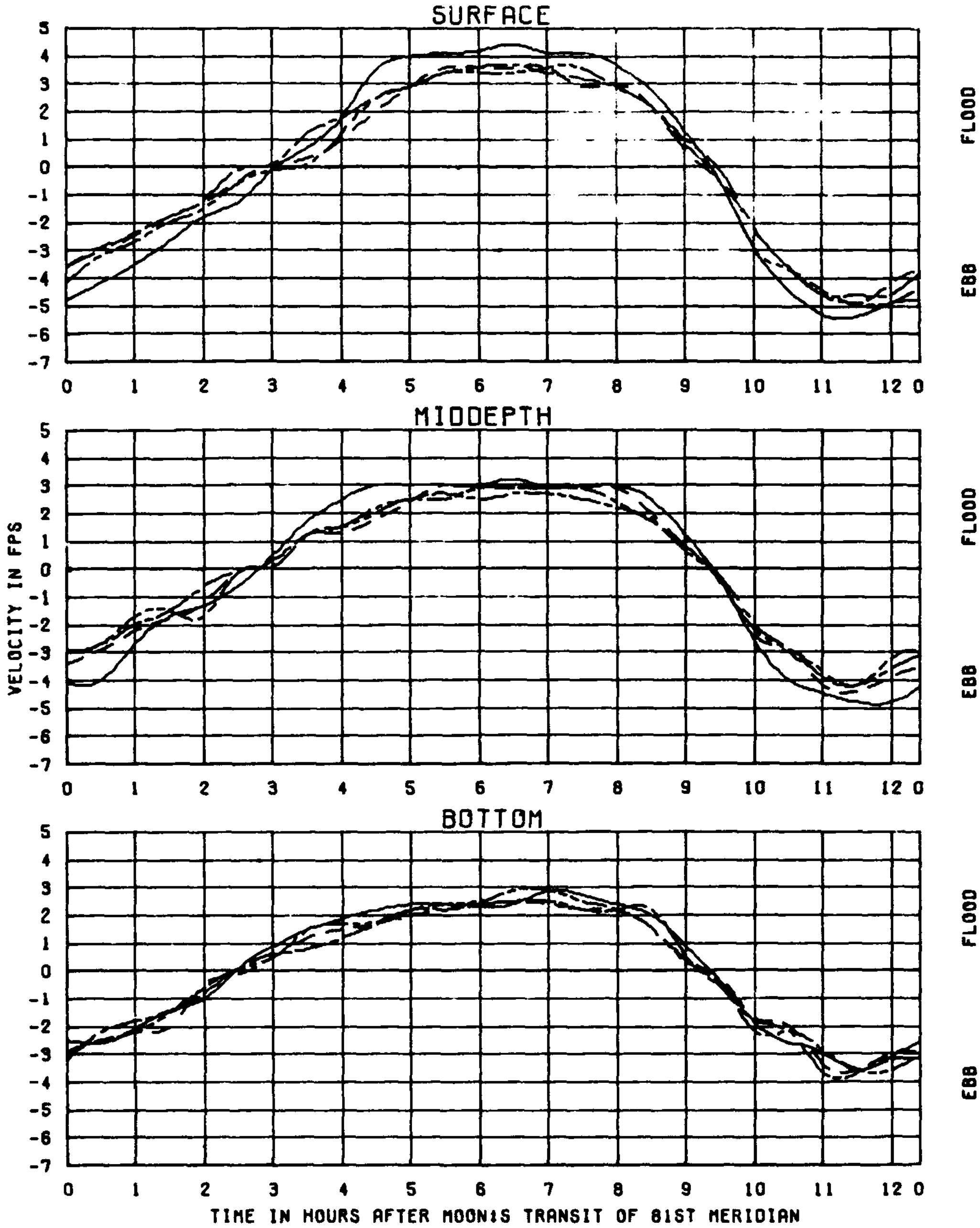
KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 2122

LEGEND

BASE ———
PLAN 2 - — —
PLAN 3 —- · —
PLAN 4 —- - - —



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

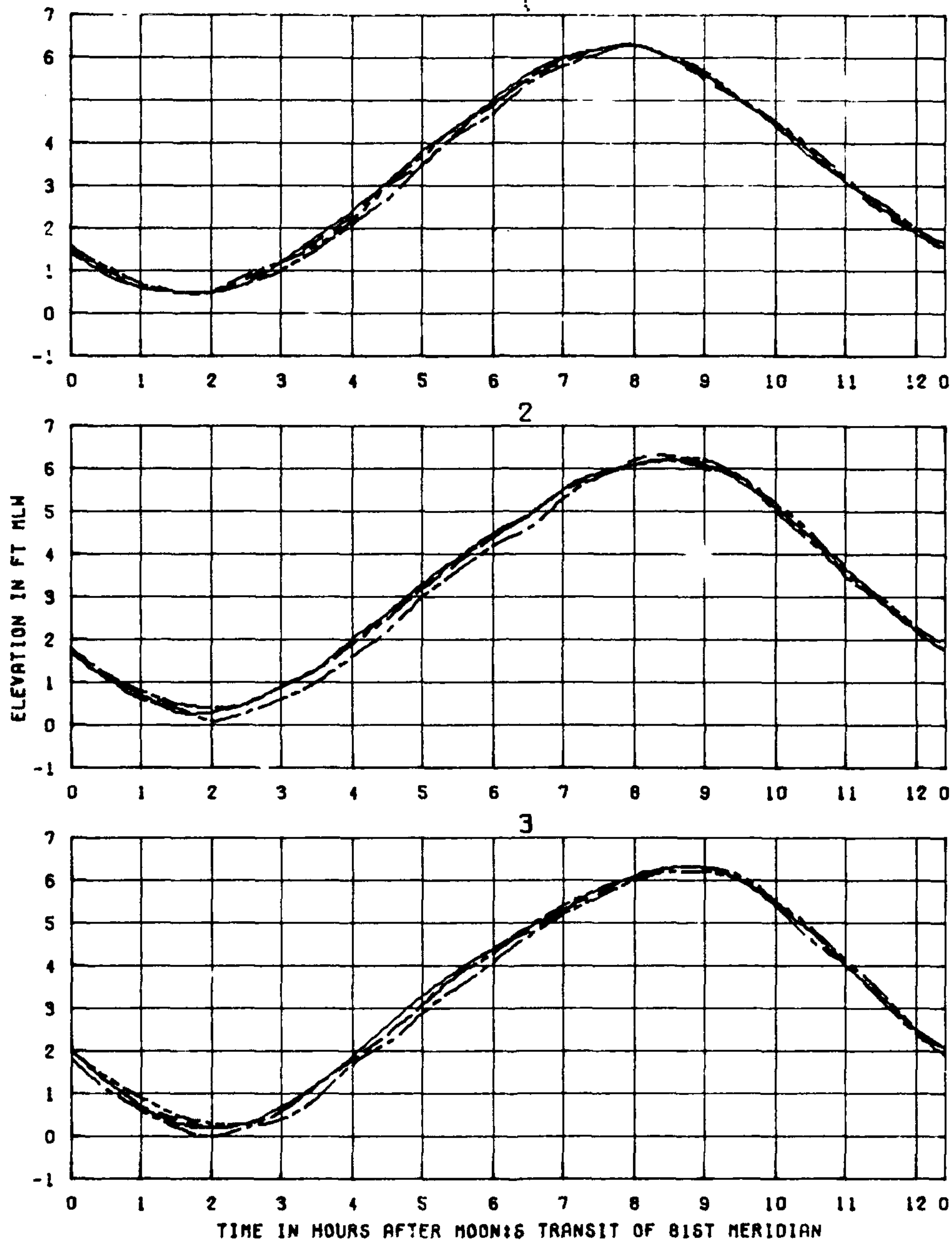
LEGEND

BASE	———
PLAN 2	— — —
PLAN 3	—·—
PLAN 4	—--—

KINGS BAY MODEL

EFFECTS OF PLANS P4-2, P4-3, AND P4-4 ON VELOCITIES

STATION 2124



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

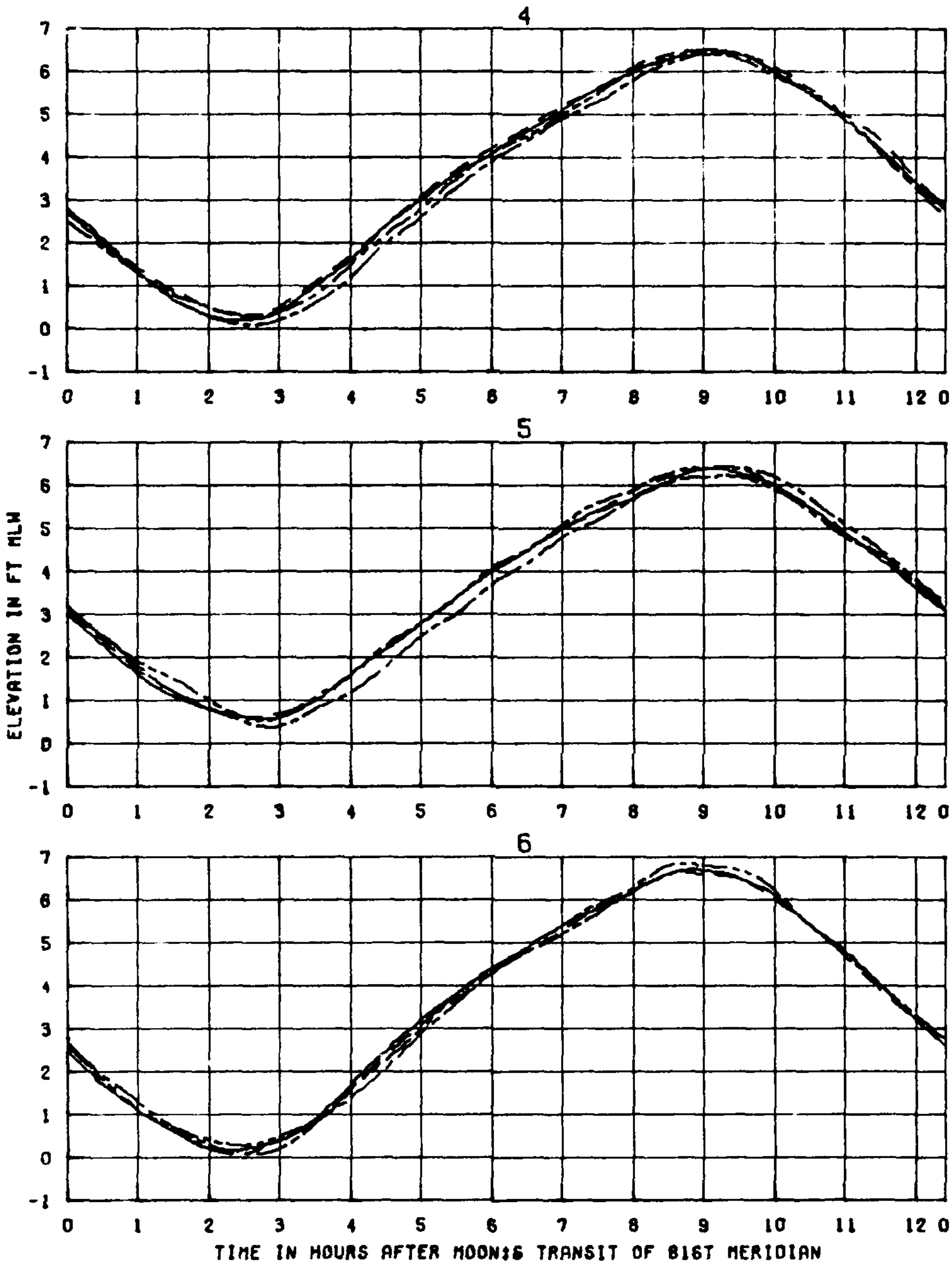
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 -----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON TIDAL HEIGHTS

STATIONS 1, 2, AND 3



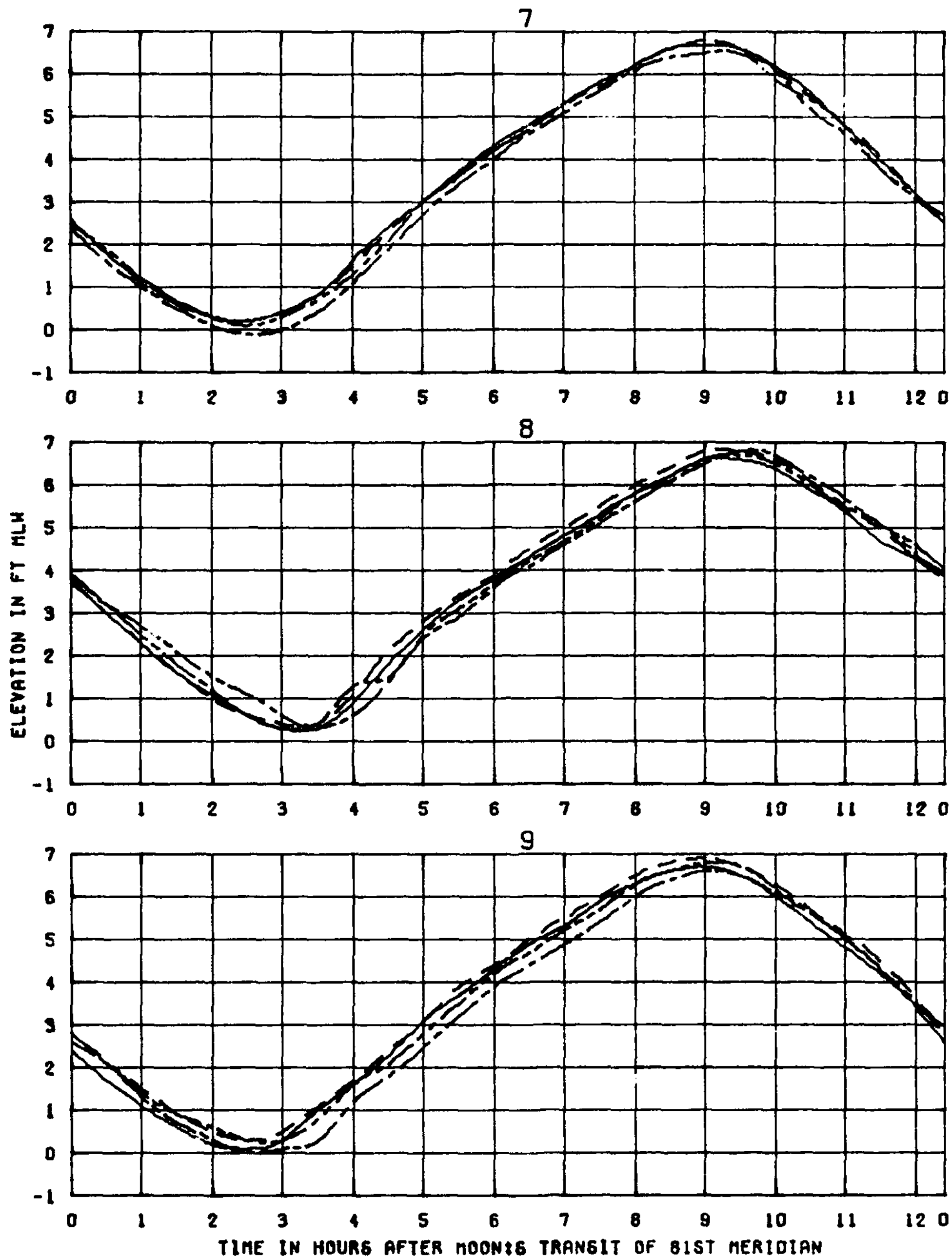
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 ----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON TIDAL HEIGHTS
STATIONS
4. 5. AND 6



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

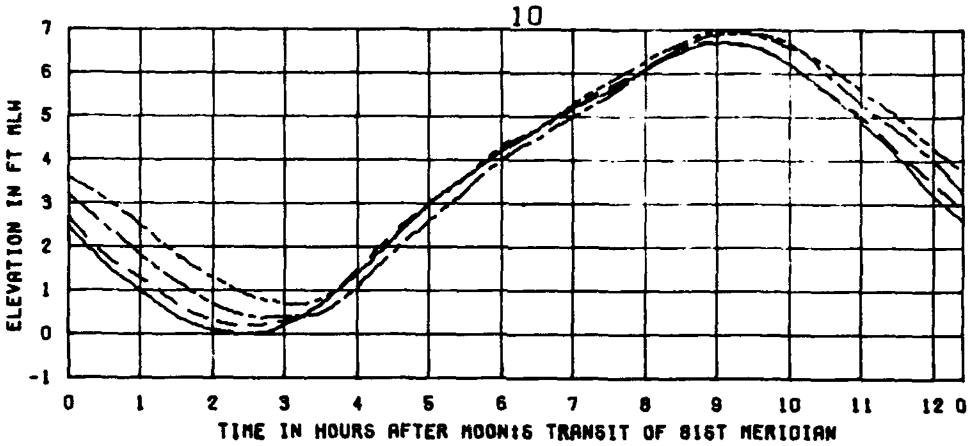
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—·—
PLAN 7 —----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON TIDAL HEIGHTS

STATIONS 7, 8, AND 9



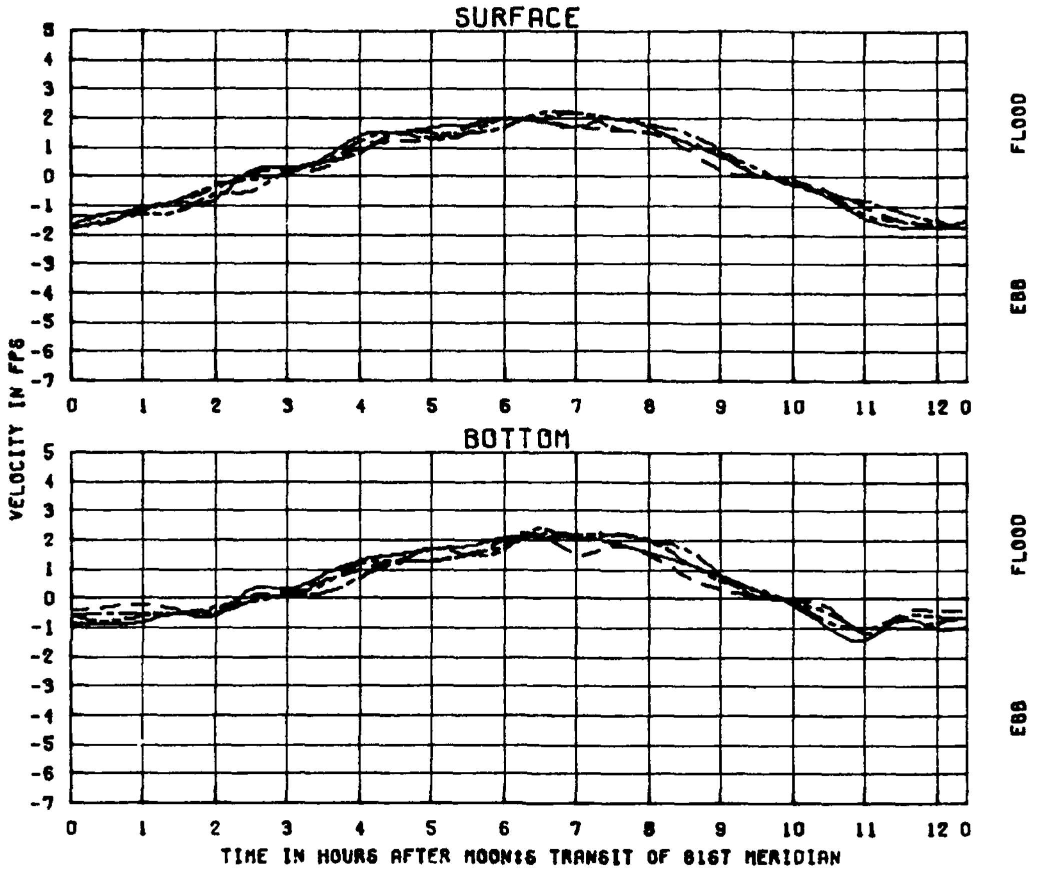
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —-—
PLAN 7 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON TIDAL HEIGHTS

STATION 10



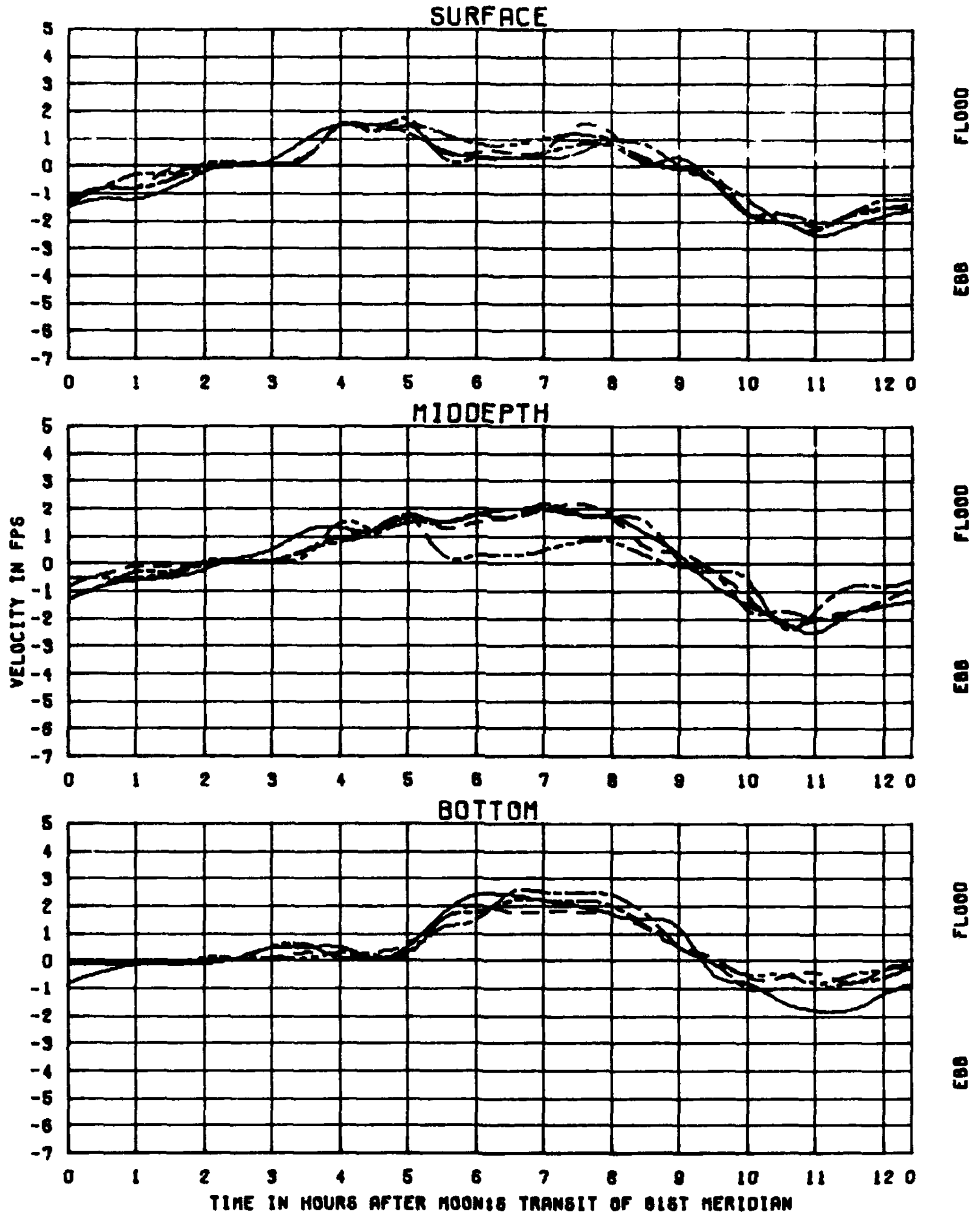
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —-·—
PLAN 7 —---—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
20



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

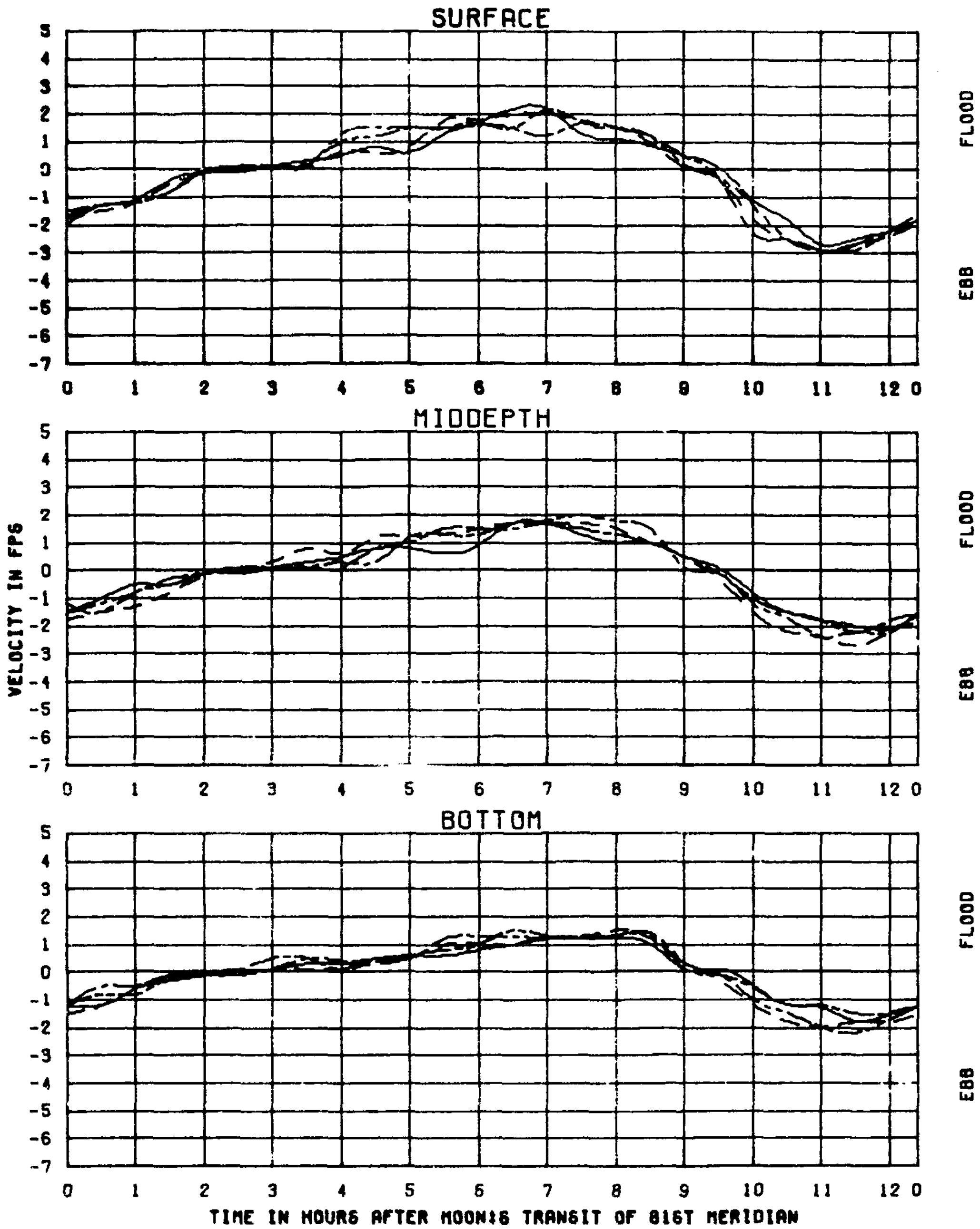
LEGEND

BASE	———
PLAN 5	— — —
PLAN 6	—·—
PLAN 7	—·-·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES

STATION
50

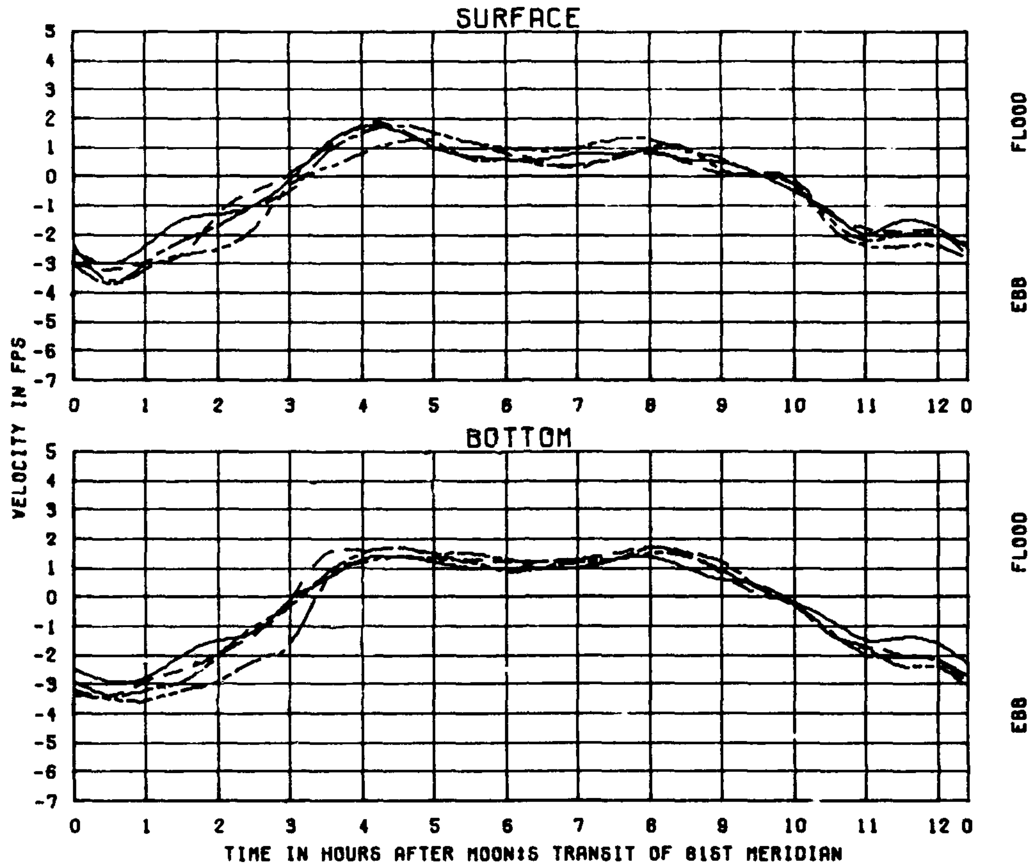


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—·—
PLAN 7 -·-·-·-

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES
STATION 60



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

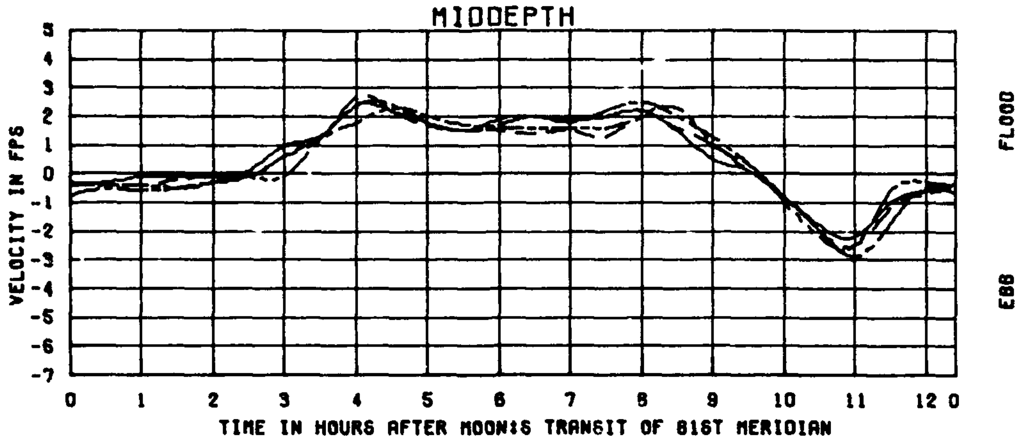
LEGEND

BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 160



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

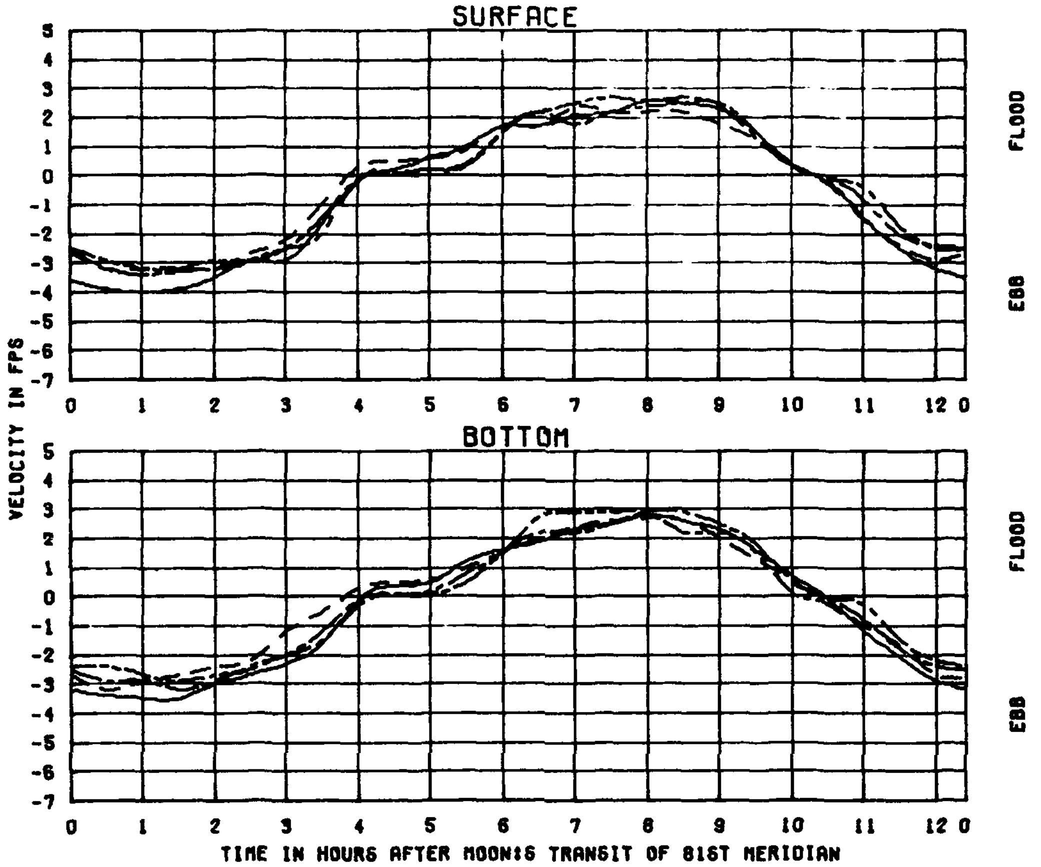
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 ——·——

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 180



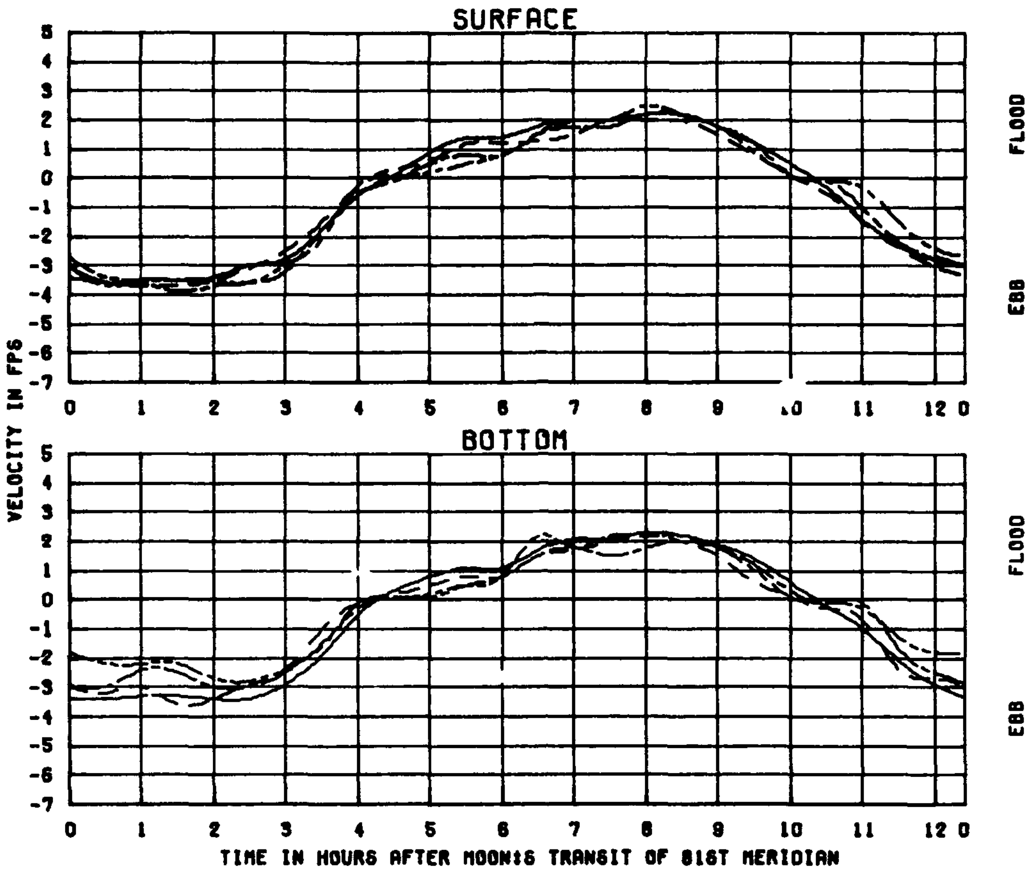
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —-—
PLAN 7 —--—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES

STATION
230

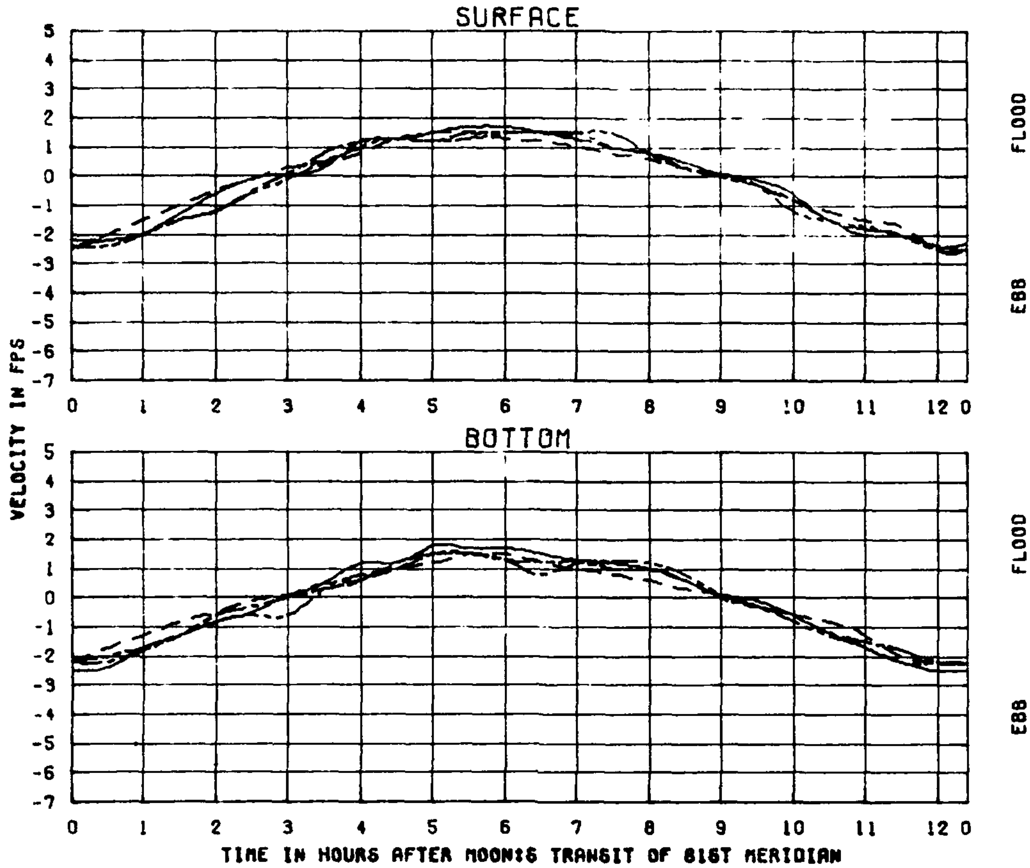


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —--—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
240

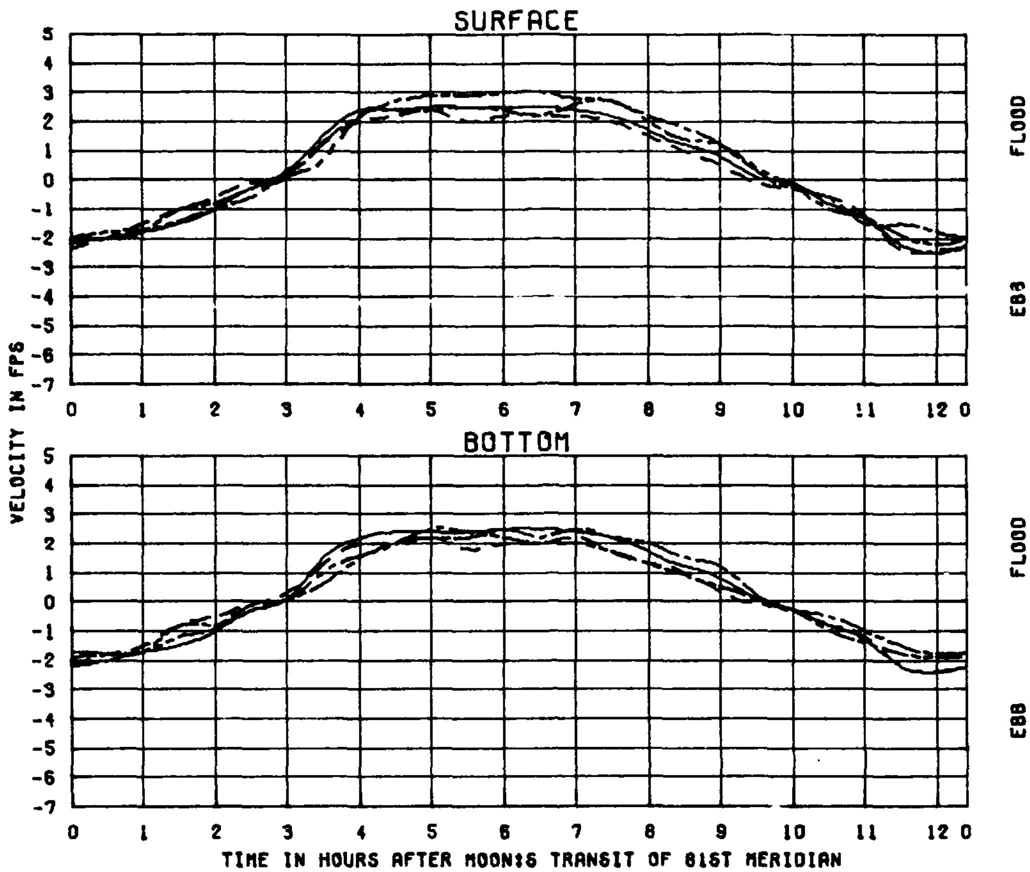


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
396

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —-—
PLAN 7 ----—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

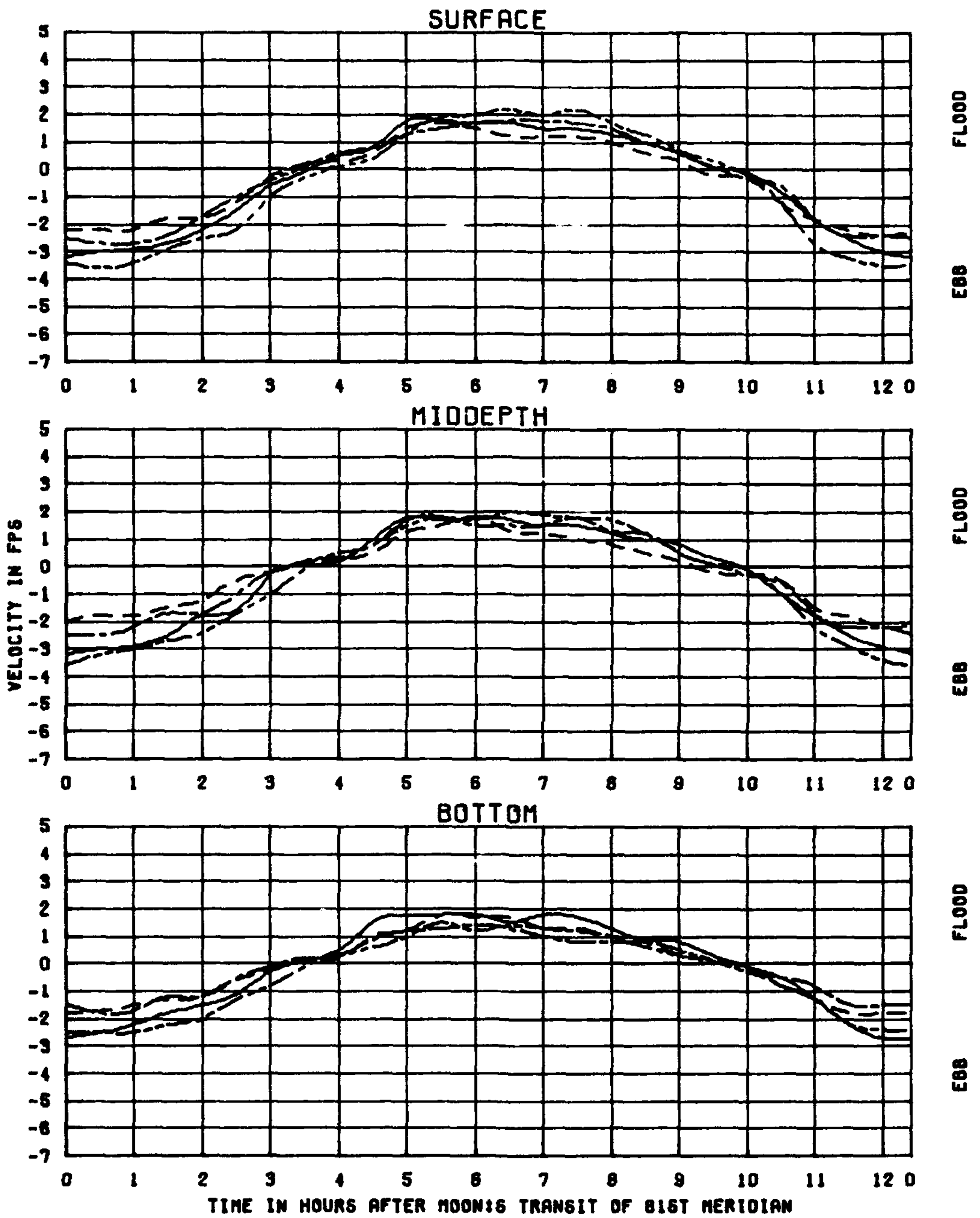
LEGEND

BASE	———
PLAN 5	— — —
PLAN 6	—·—
PLAN 7	—··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5,P4-6,AND P4-7
ON VELOCITIES

STATION
584

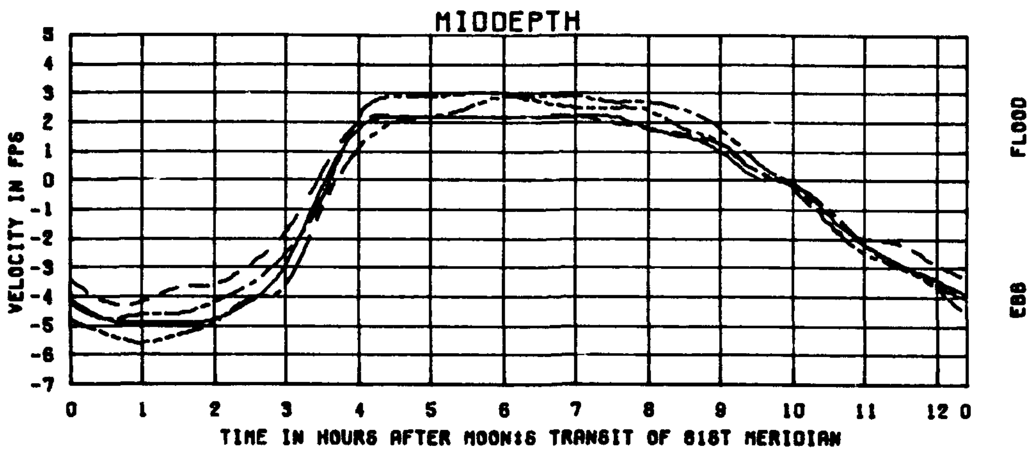


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
650

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —--—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

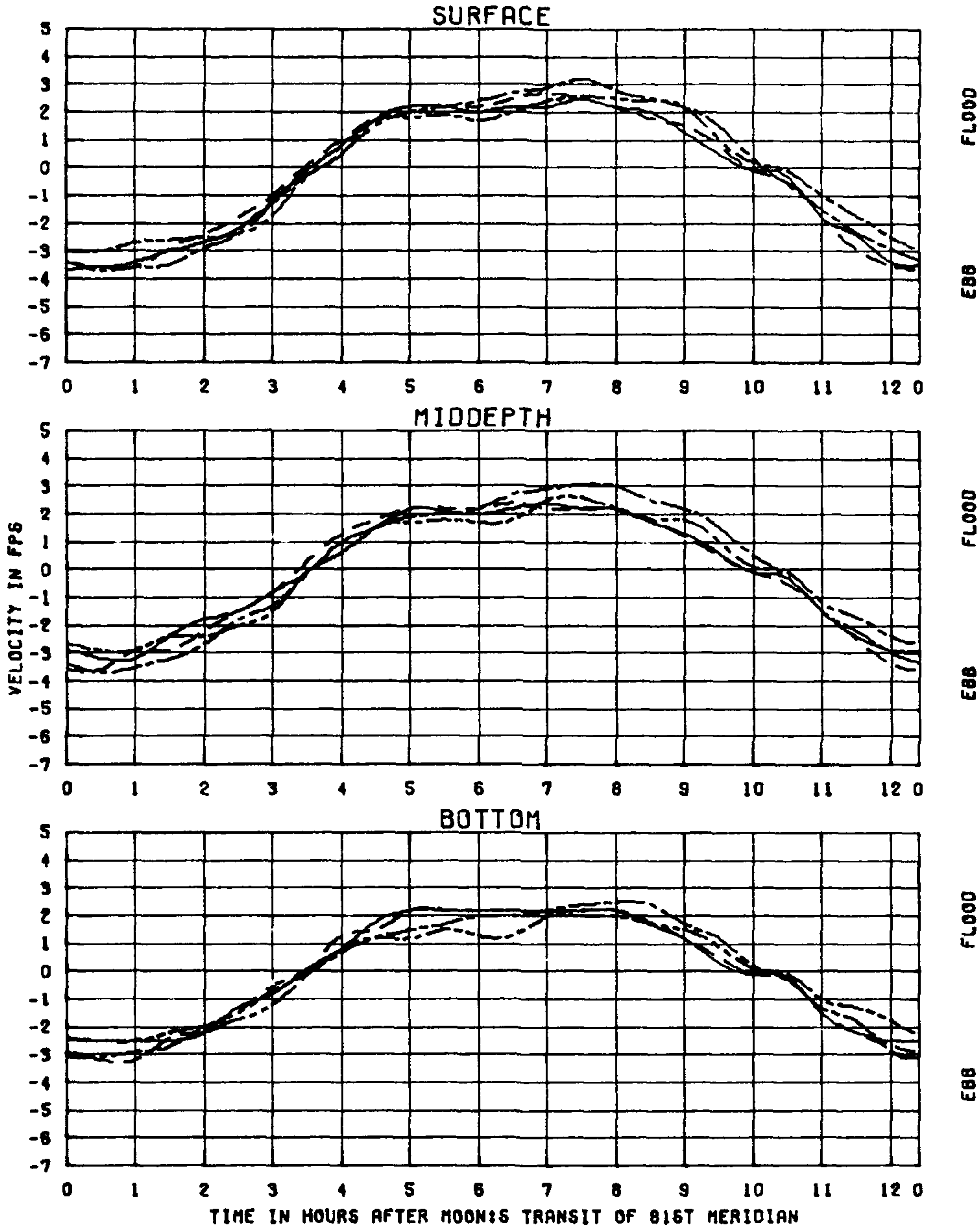
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5,P4-6,AND P4-7 ON VELOCITIES

STATION

812



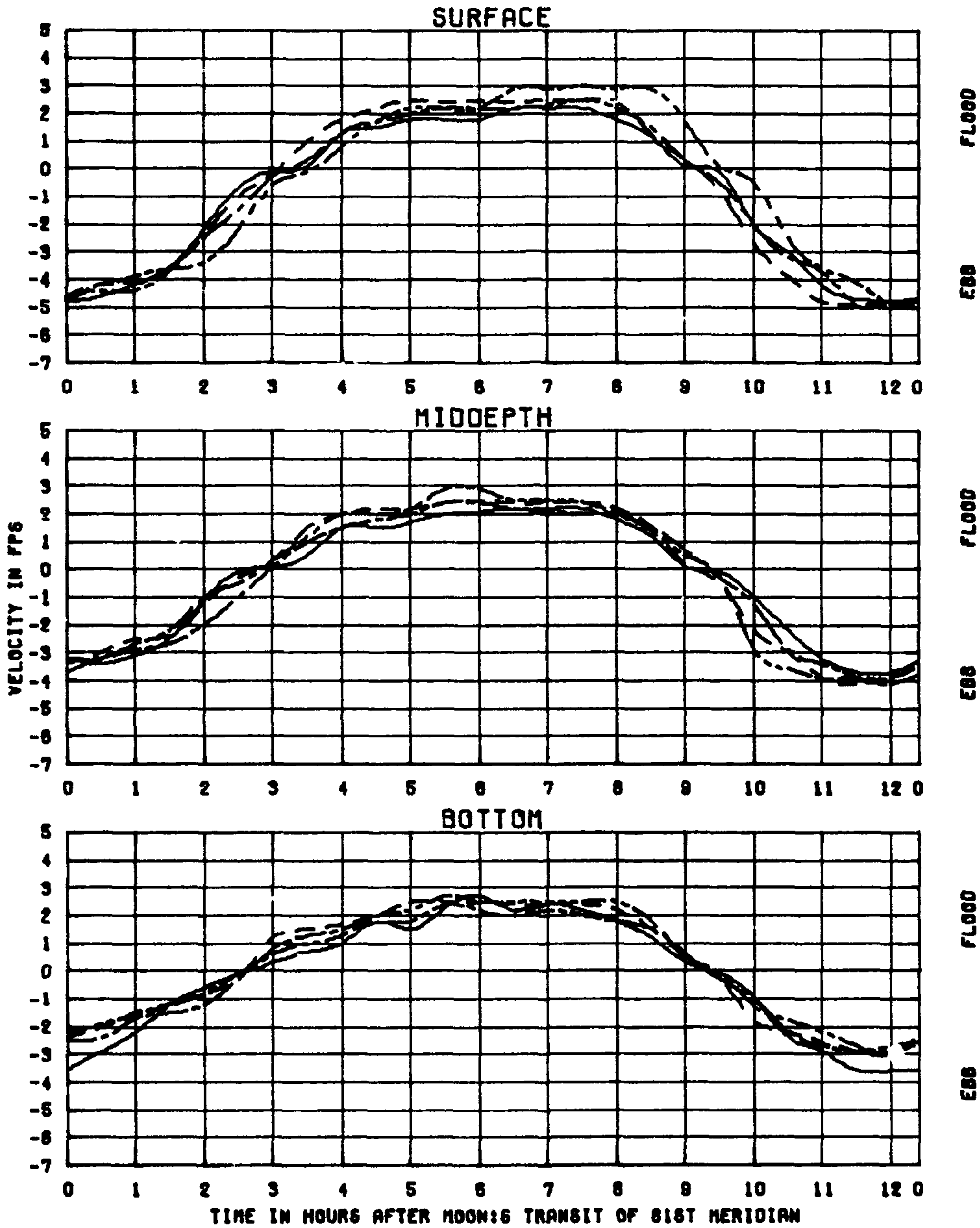
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
818

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —--—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

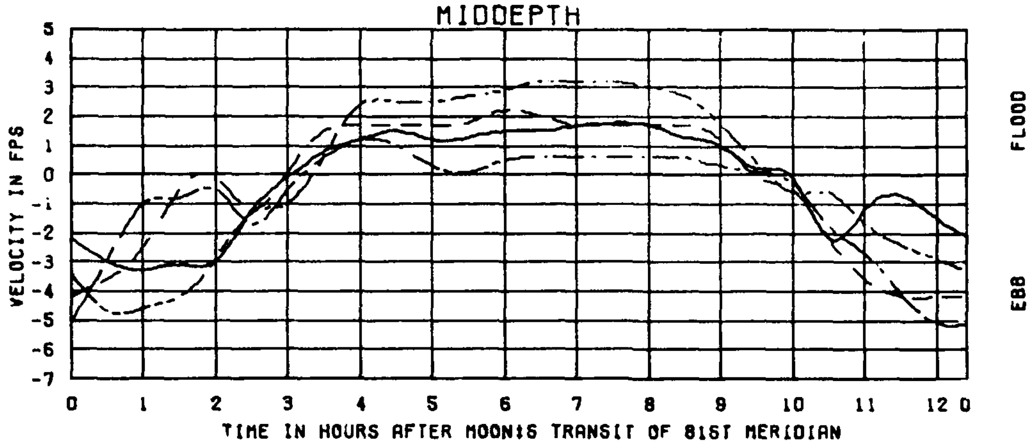
LEGEND

BASE
PLAN 5
PLAN 6
PLAN 7

KINGS BAY MODEL

EFFECTS OF PLANS P4-5,P4-6,AND P4-7 ON VELOCITIES

STATION 843



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

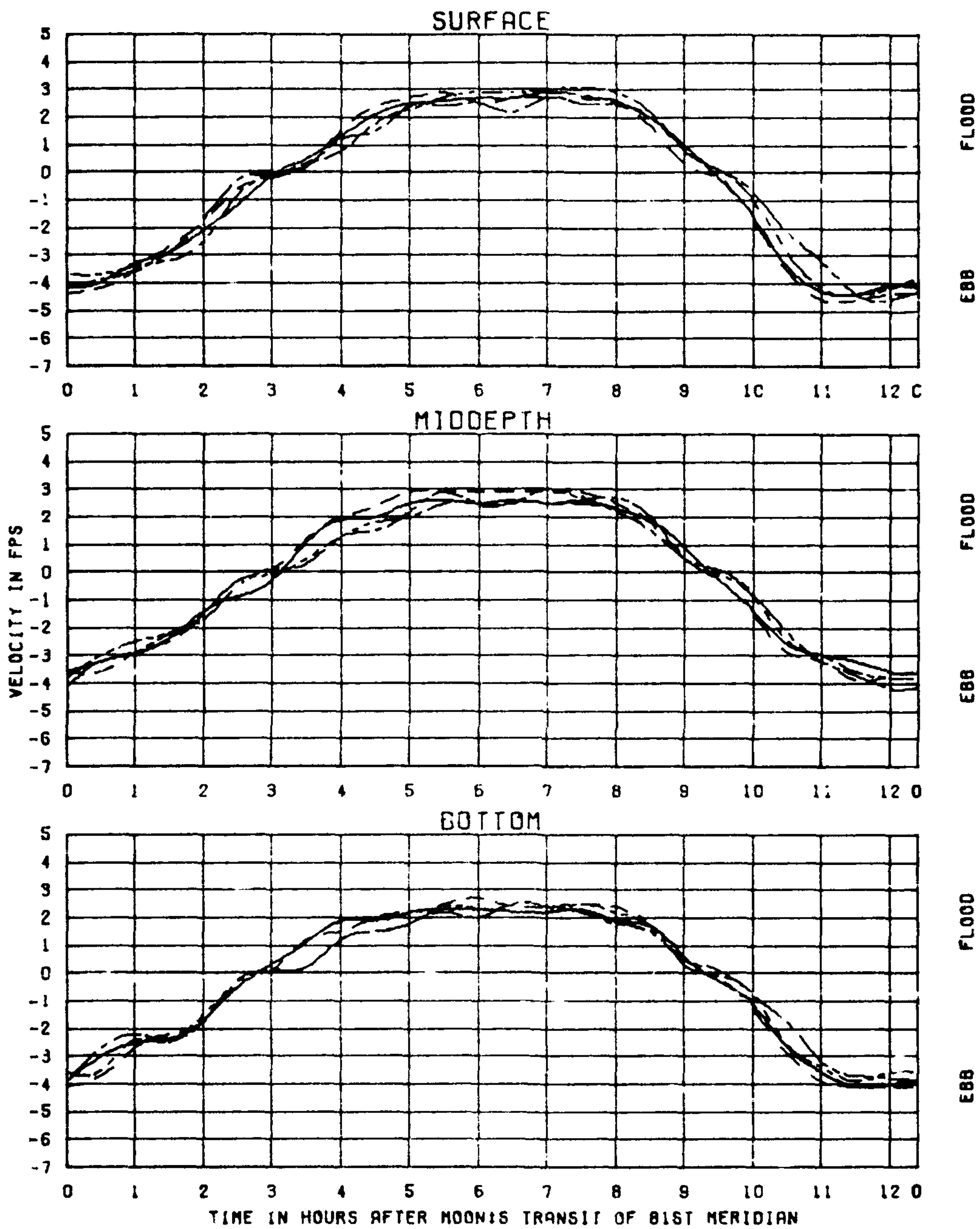
LEGEND

BASE	———
PLAN 5	— — —
PLAN 6	—·—
PLAN 7	—··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES

STATION
1014



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

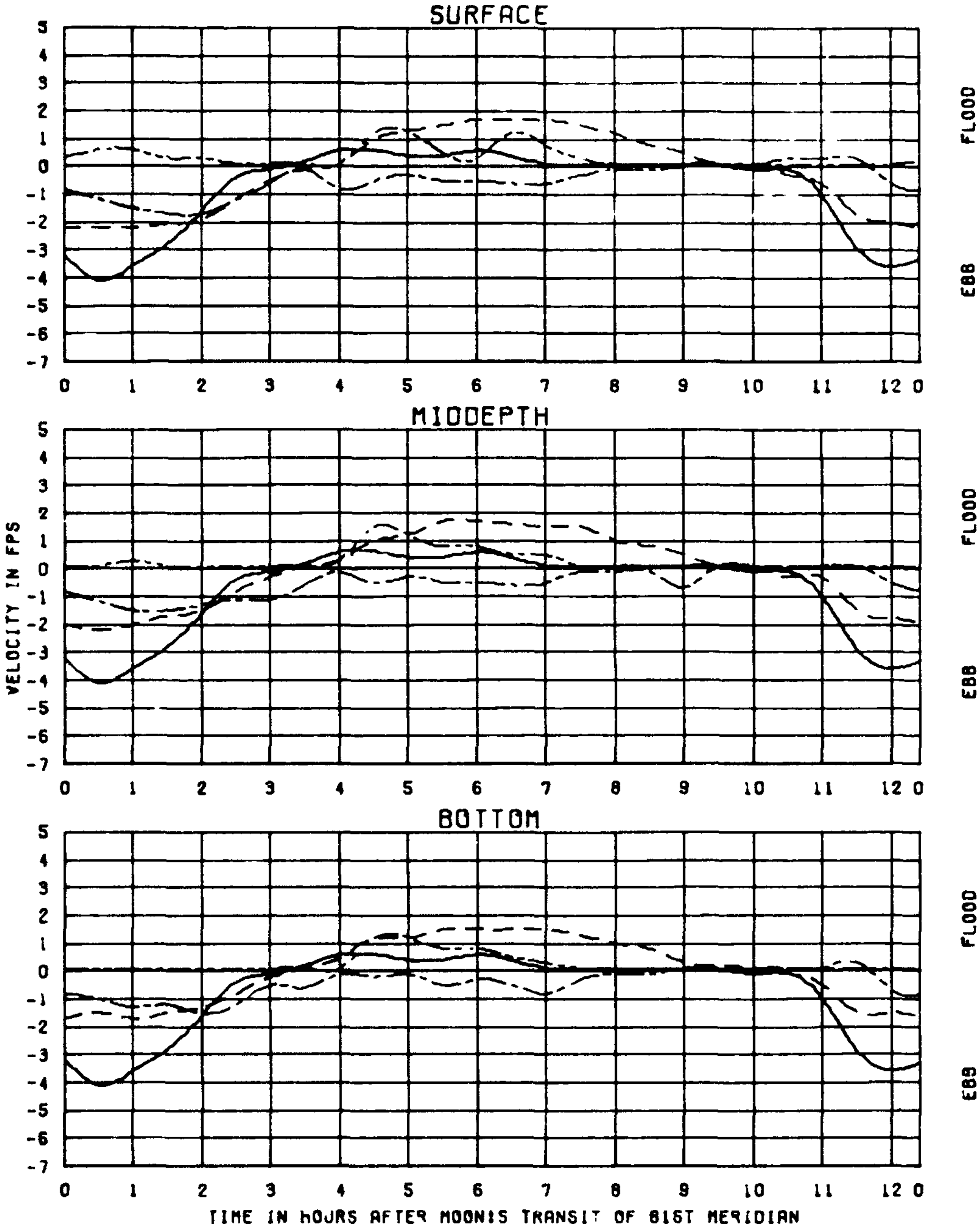
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —-·—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1055



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

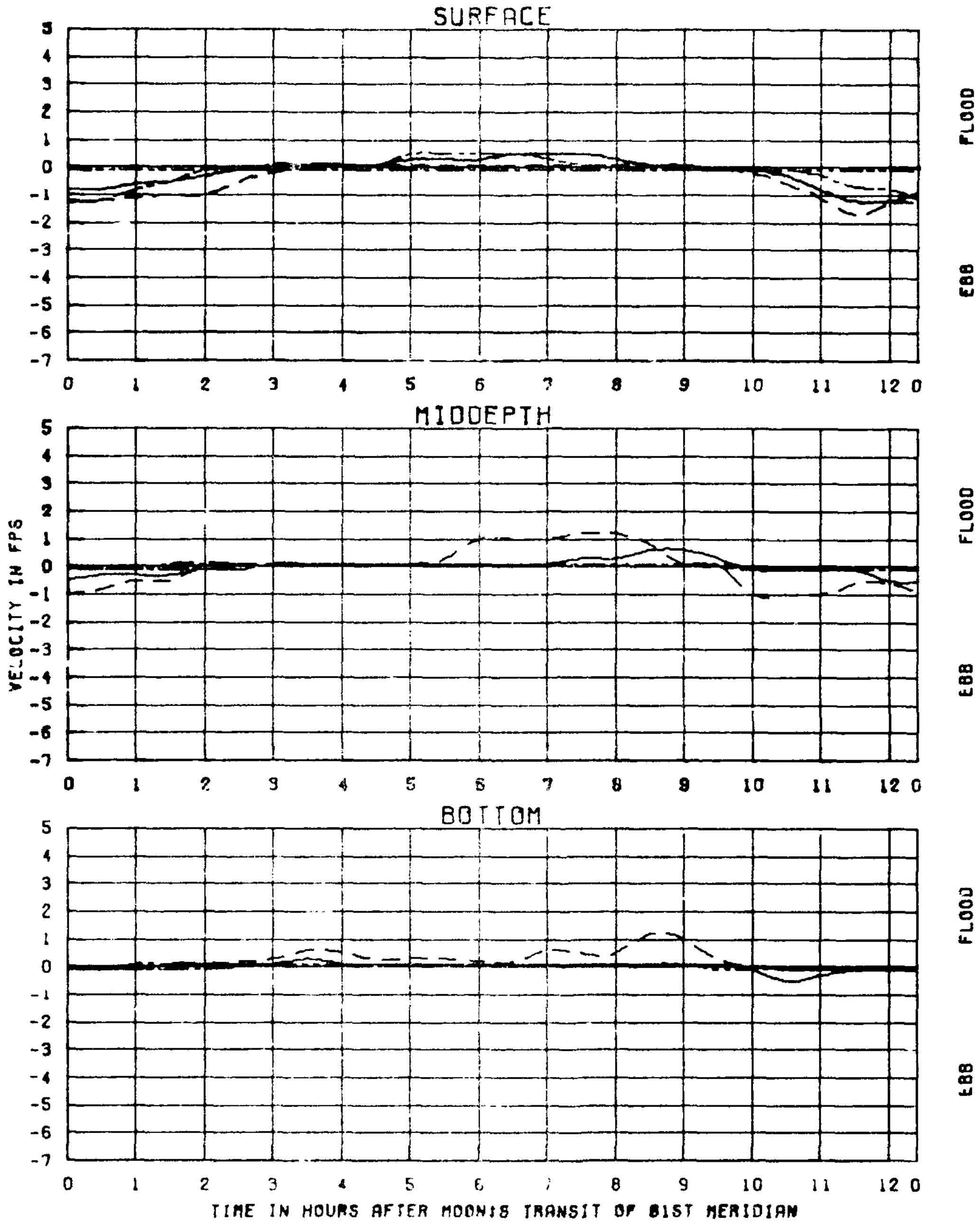
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1066



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

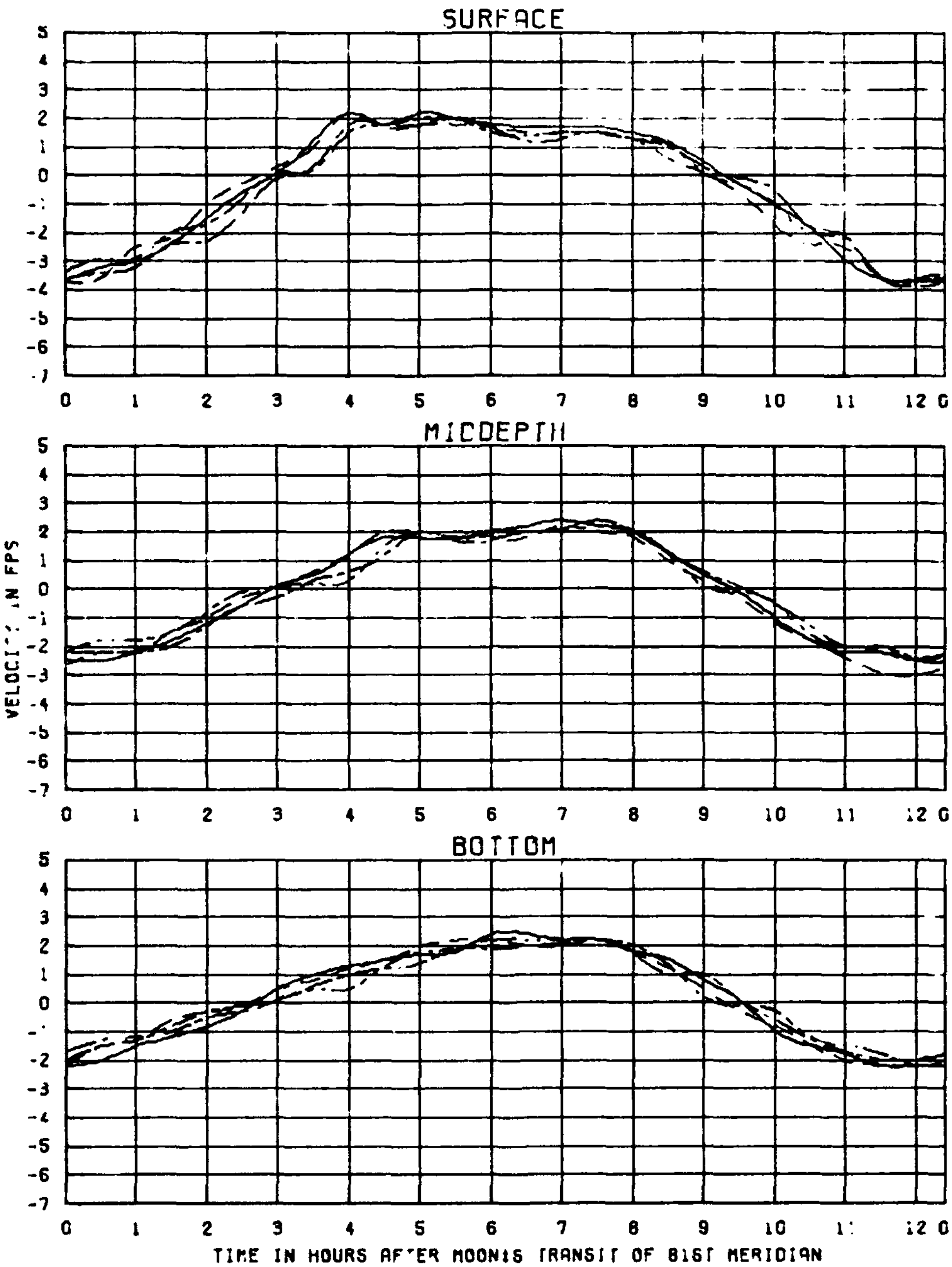
LEGEND

BASE ———
PLAN 5 — — —
PLAN 6 —-—
PLAN 7 —--—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5,P4-6,AND P4-7 ON VELOCITIES

STATION 1142



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

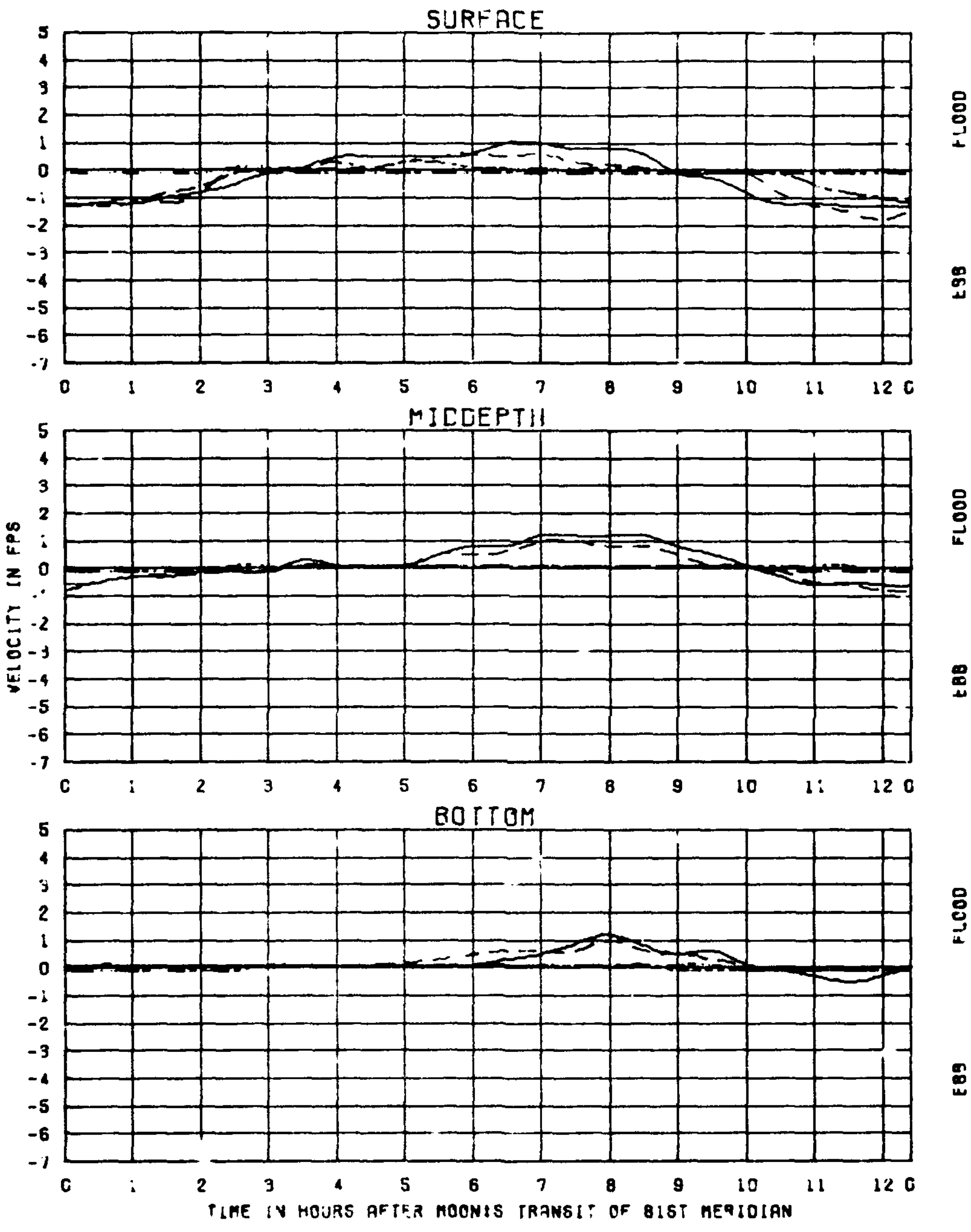
KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1153

LEGEND

BASE ———
PLAN 5 — -- -
PLAN 6 —-—
PLAN 7 —·-—



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

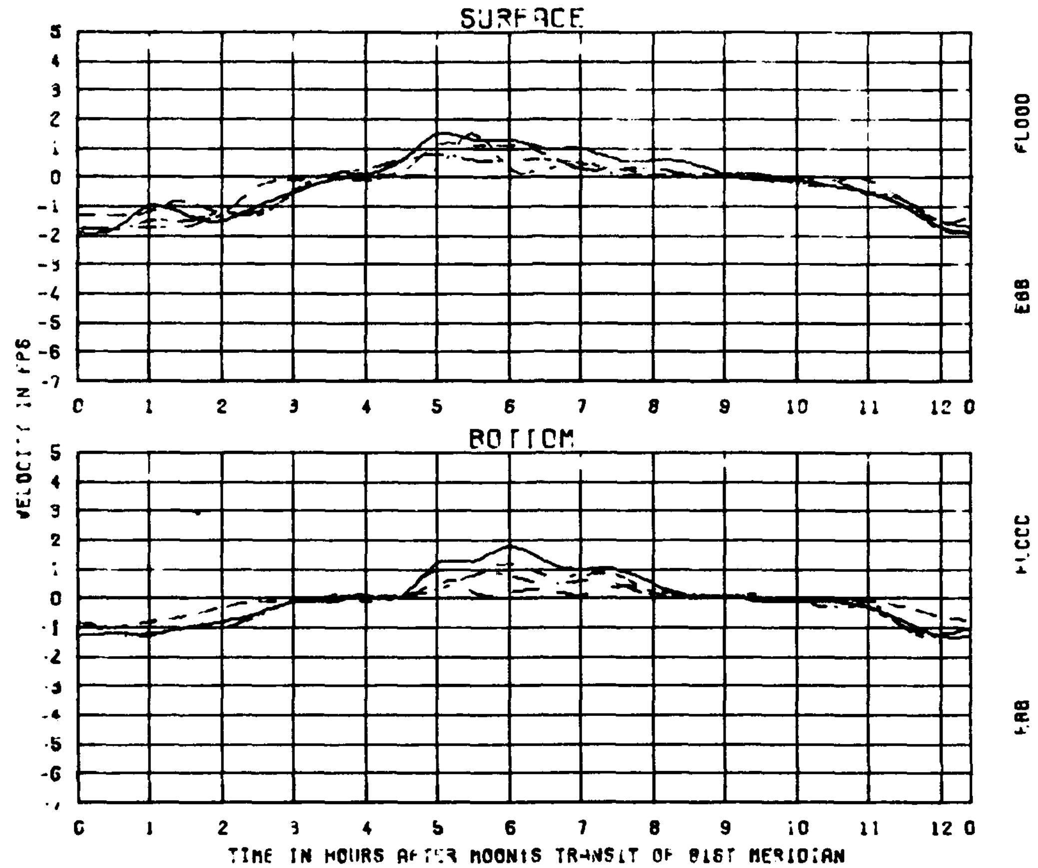
BASE ————
PLAN 5 — — - - -
PLAN 6 ——- —
PLAN 7 —— · —

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION

1182



TEST CONDITIONS

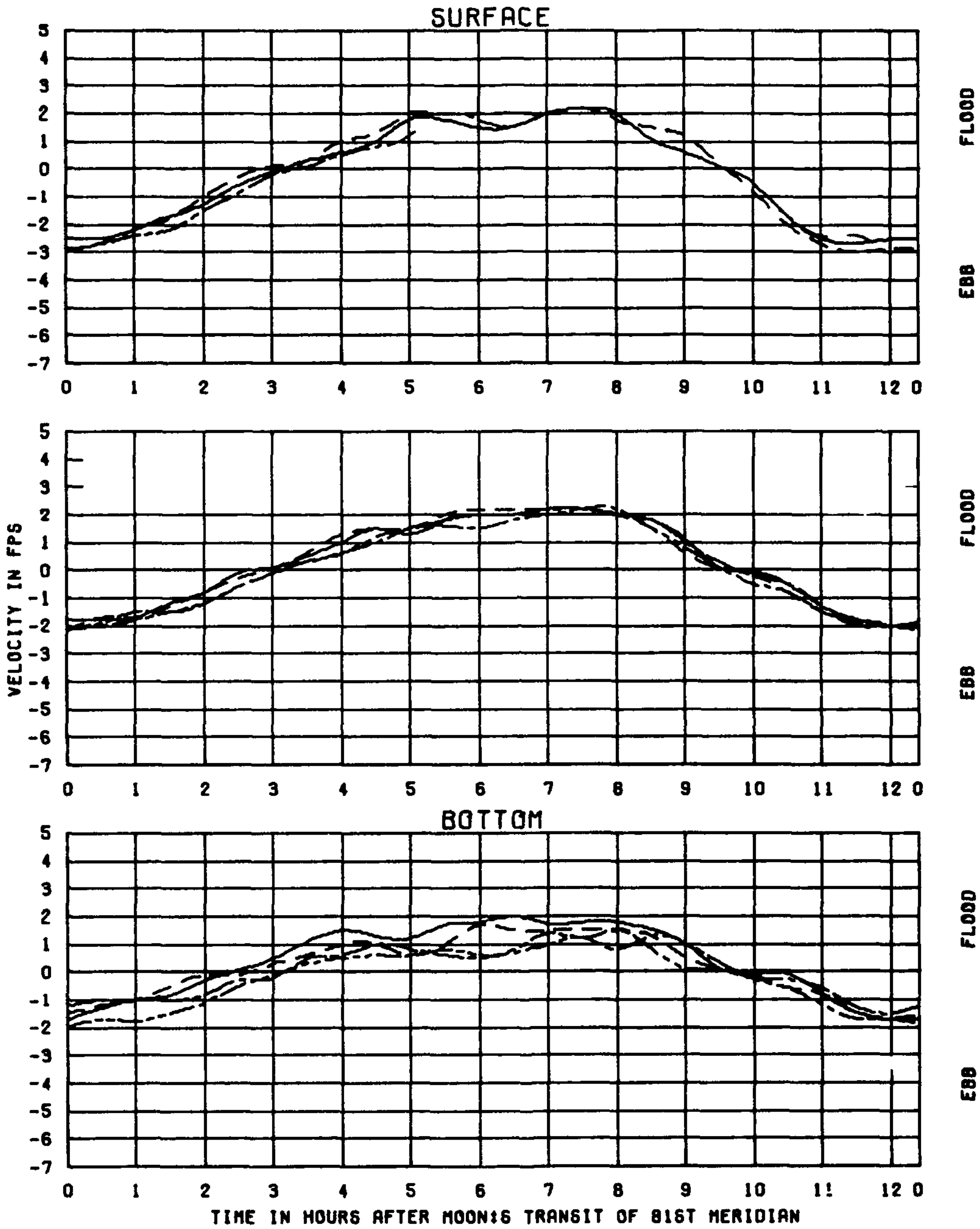
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
1276

LEGEND

BASE ———
PLAN 5 — — —
PLAN 6 —·—·—
PLAN 7 —·· ·



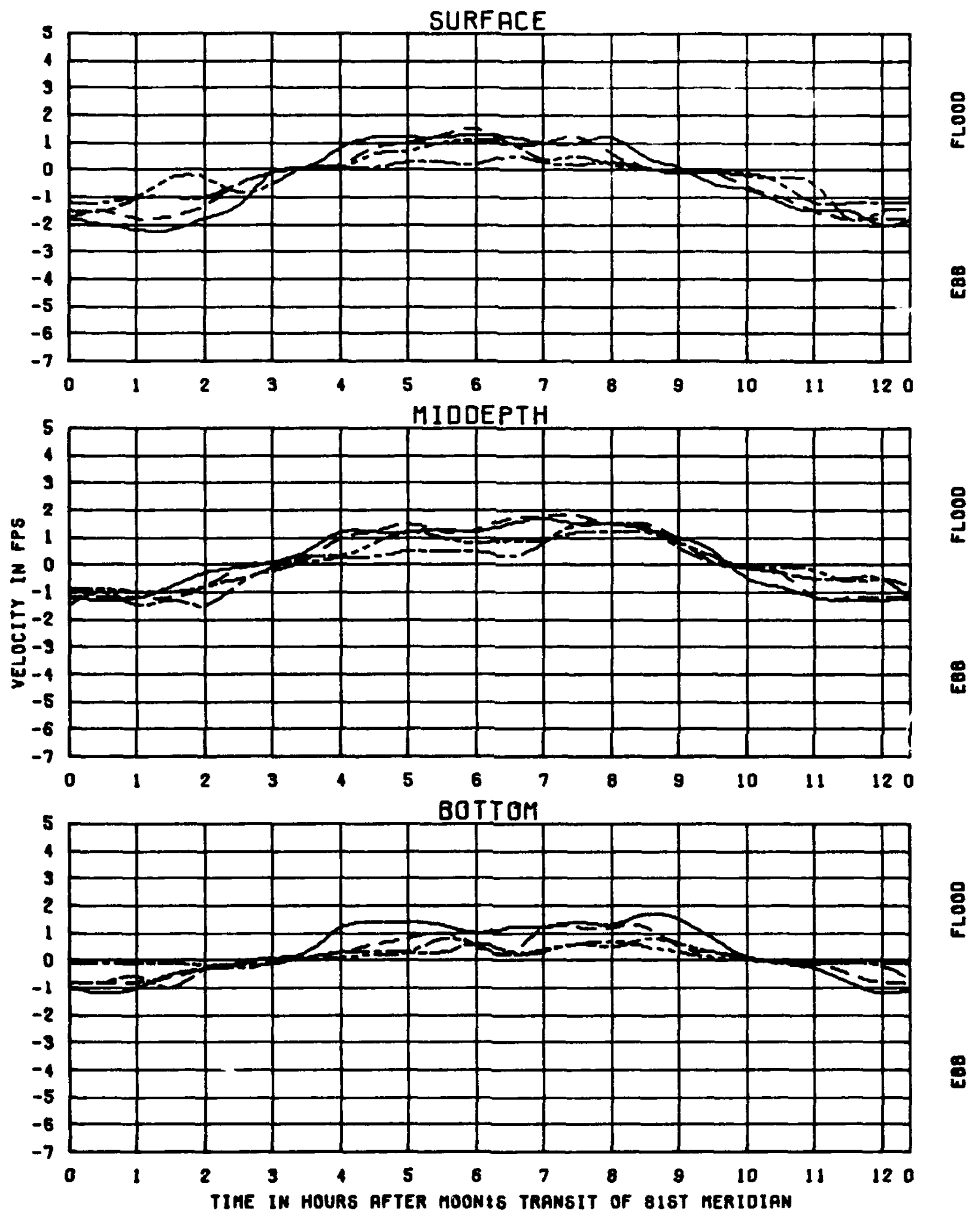
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —---—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1385



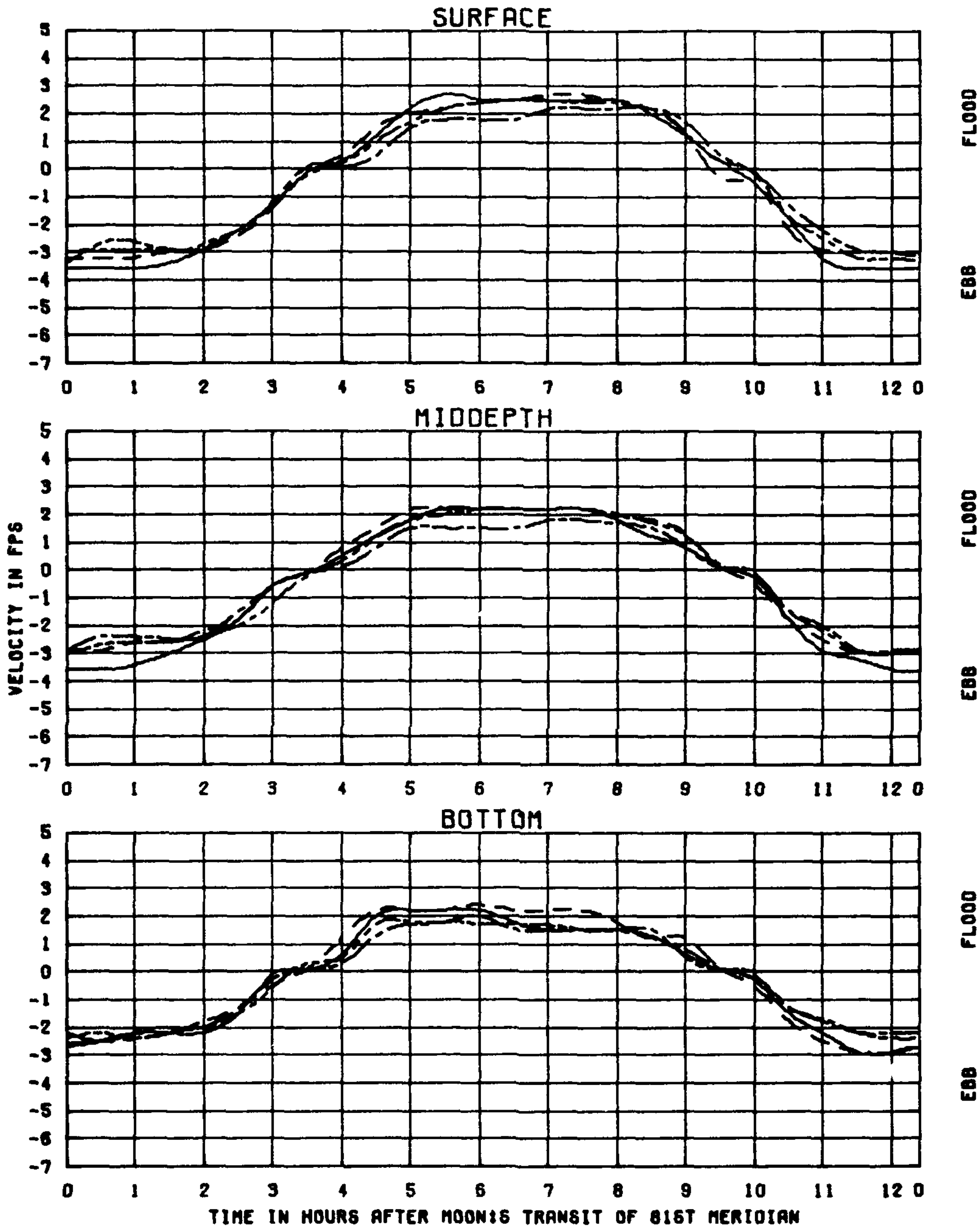
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —--—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
1851

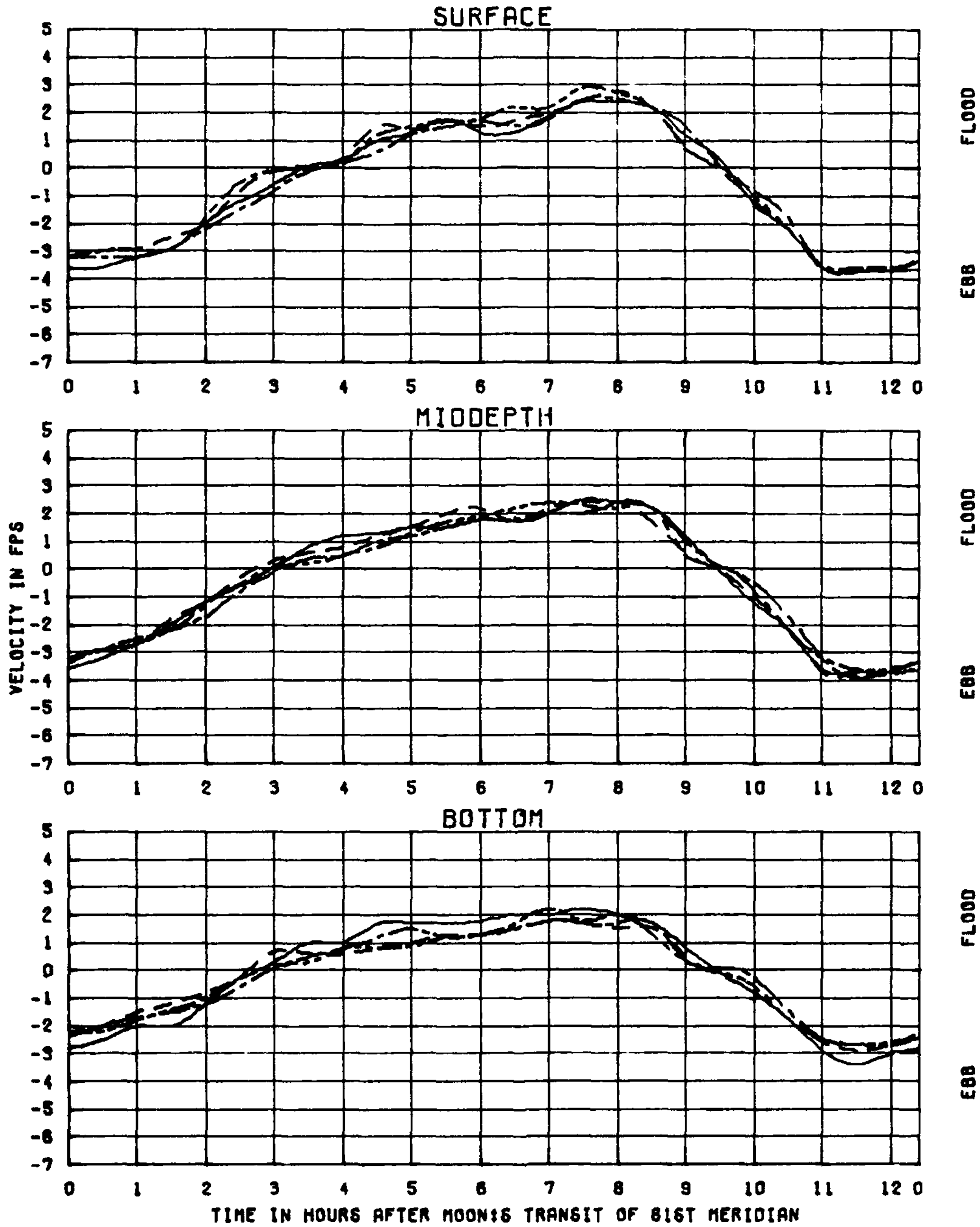


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
1865

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 ----—



TEST CONDITIONS

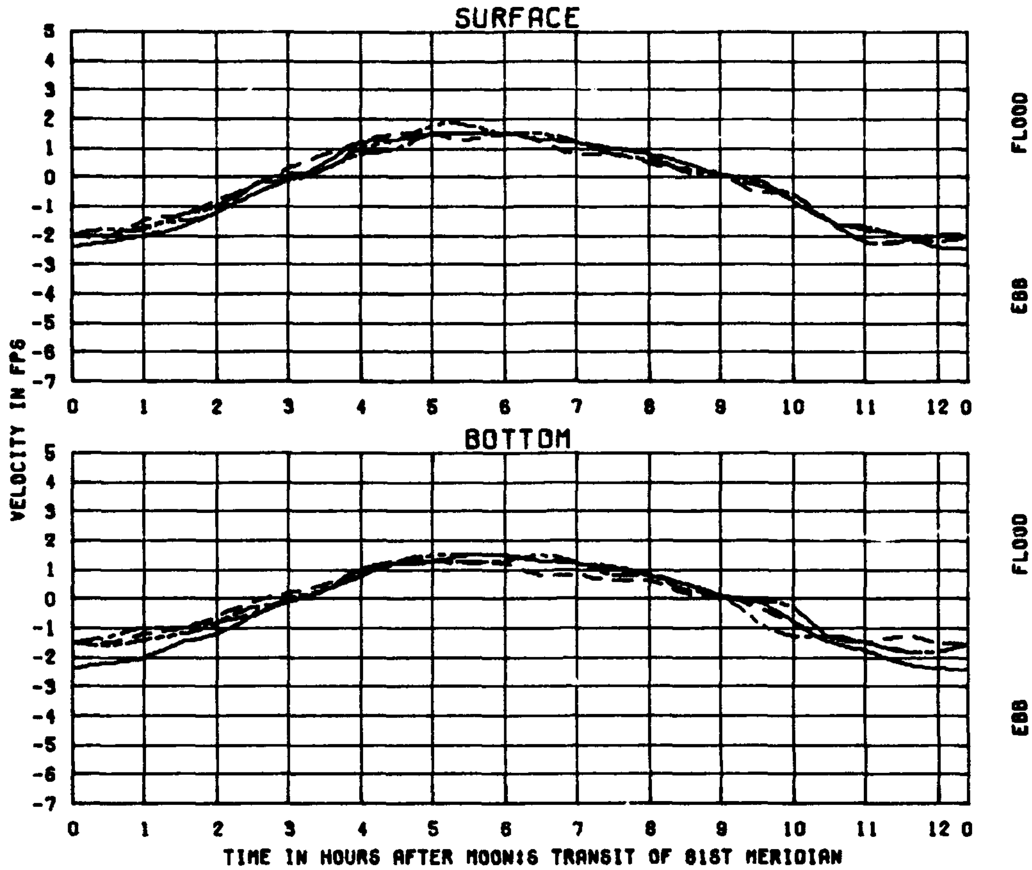
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION
1869



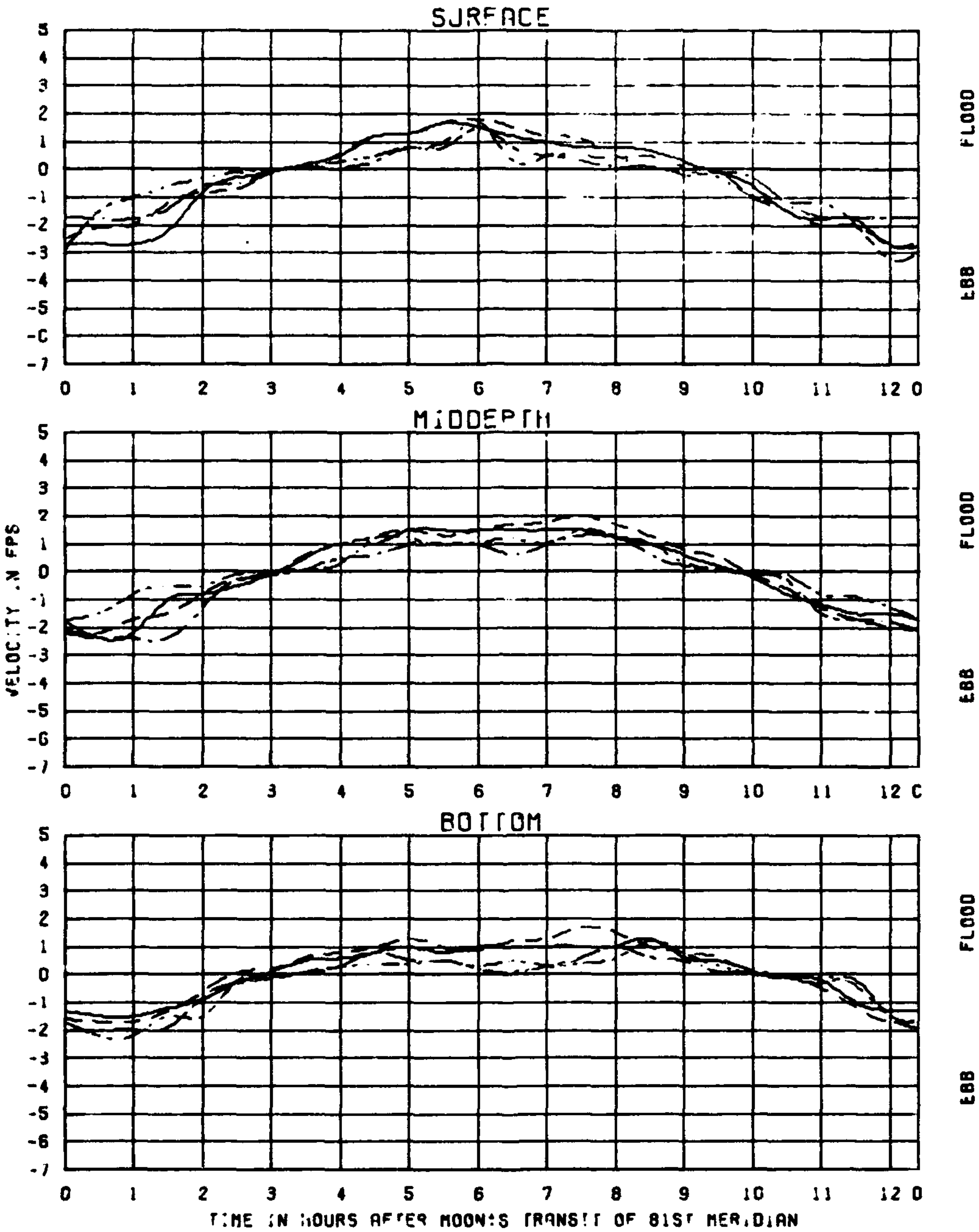
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —----

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1883

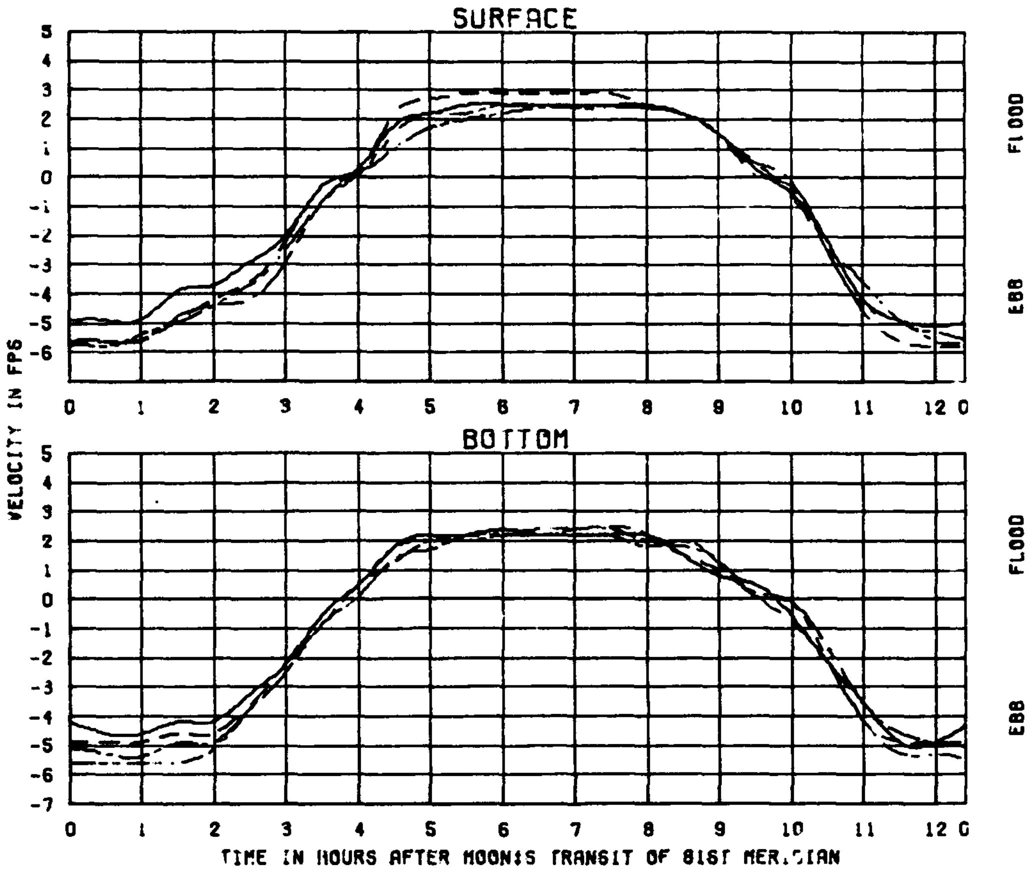


TEST CONDITIONS	
TIDE RANGE AT GAGE :	5.8 FT
OCEAN SALINITY (SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 5 — — —
PLAN 6 —— ——
PLAN 7 —··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
1915



TEST CONDITIONS

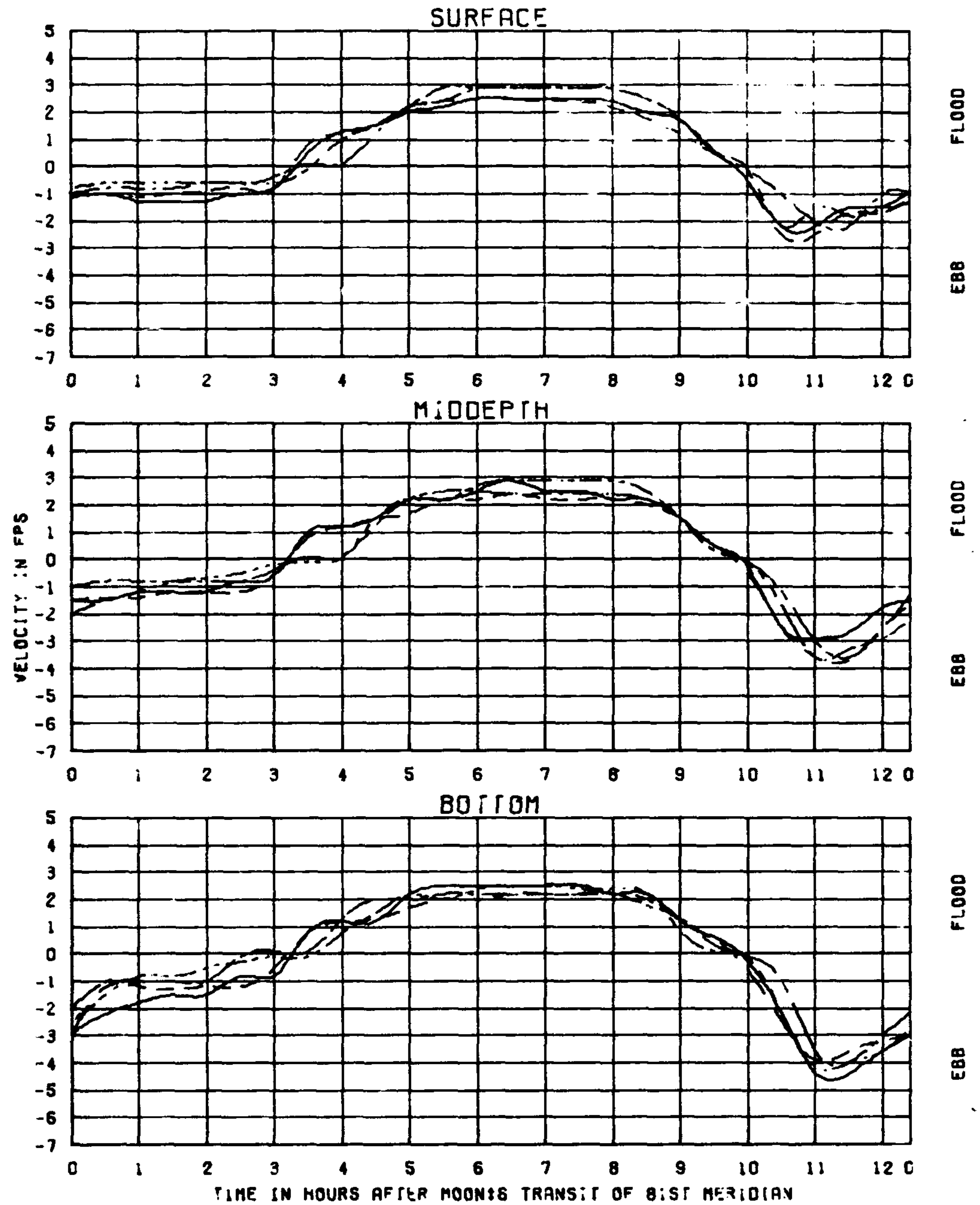
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———
PLAN 5 — — —
PLAN 6 —··—
PLAN 7 —·—·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5,P4-6,AND P4-7
ON VELOCITIES
STATION
1979



TEST CONDITIONS

TIDE RANGE AT ONCE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

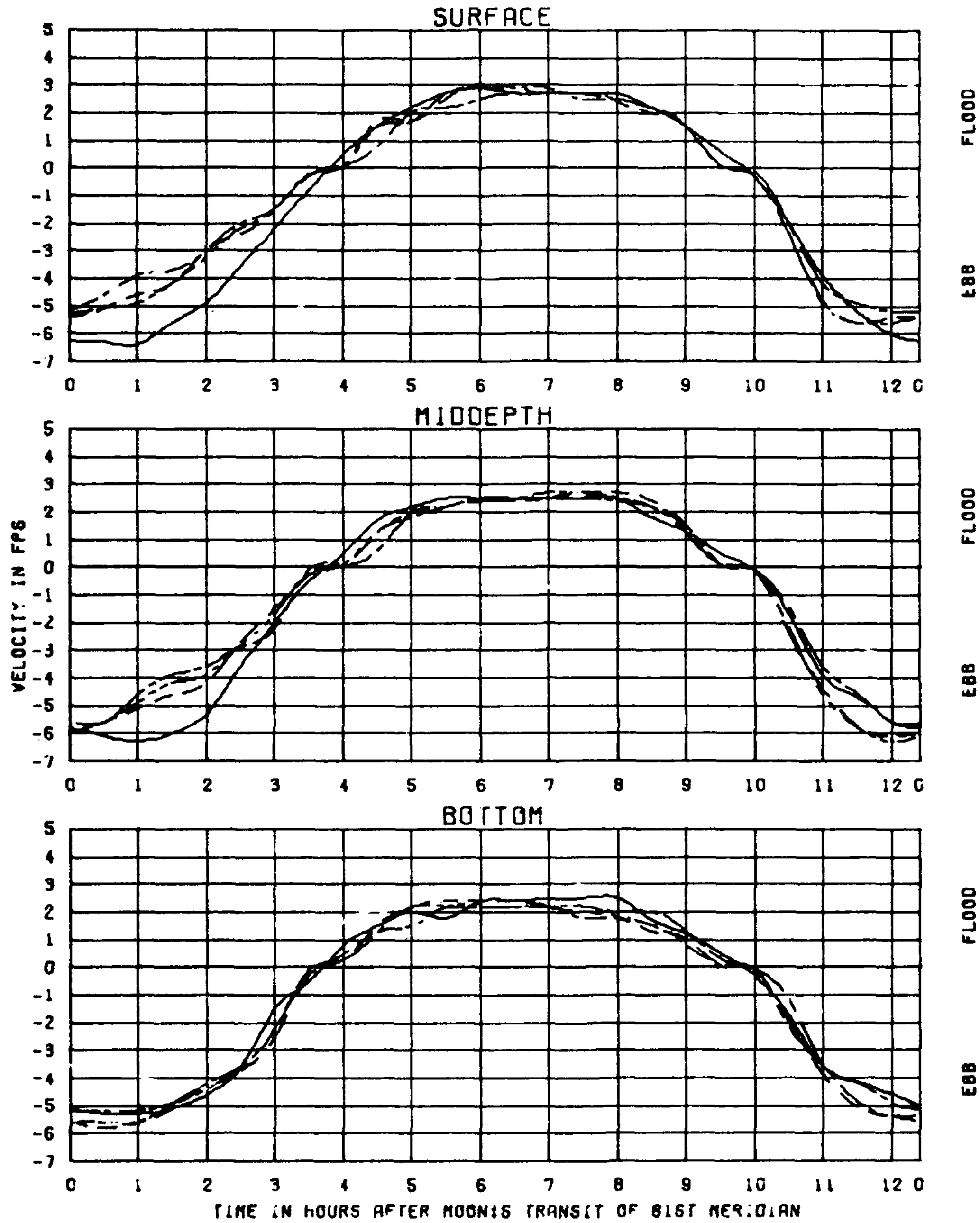
LEGEND

BASE	———
PLAN 5	— — —
PLAN 6	—·—
PLAN 7	—··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES

STATION
1981



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———

PLAN 5 — — —

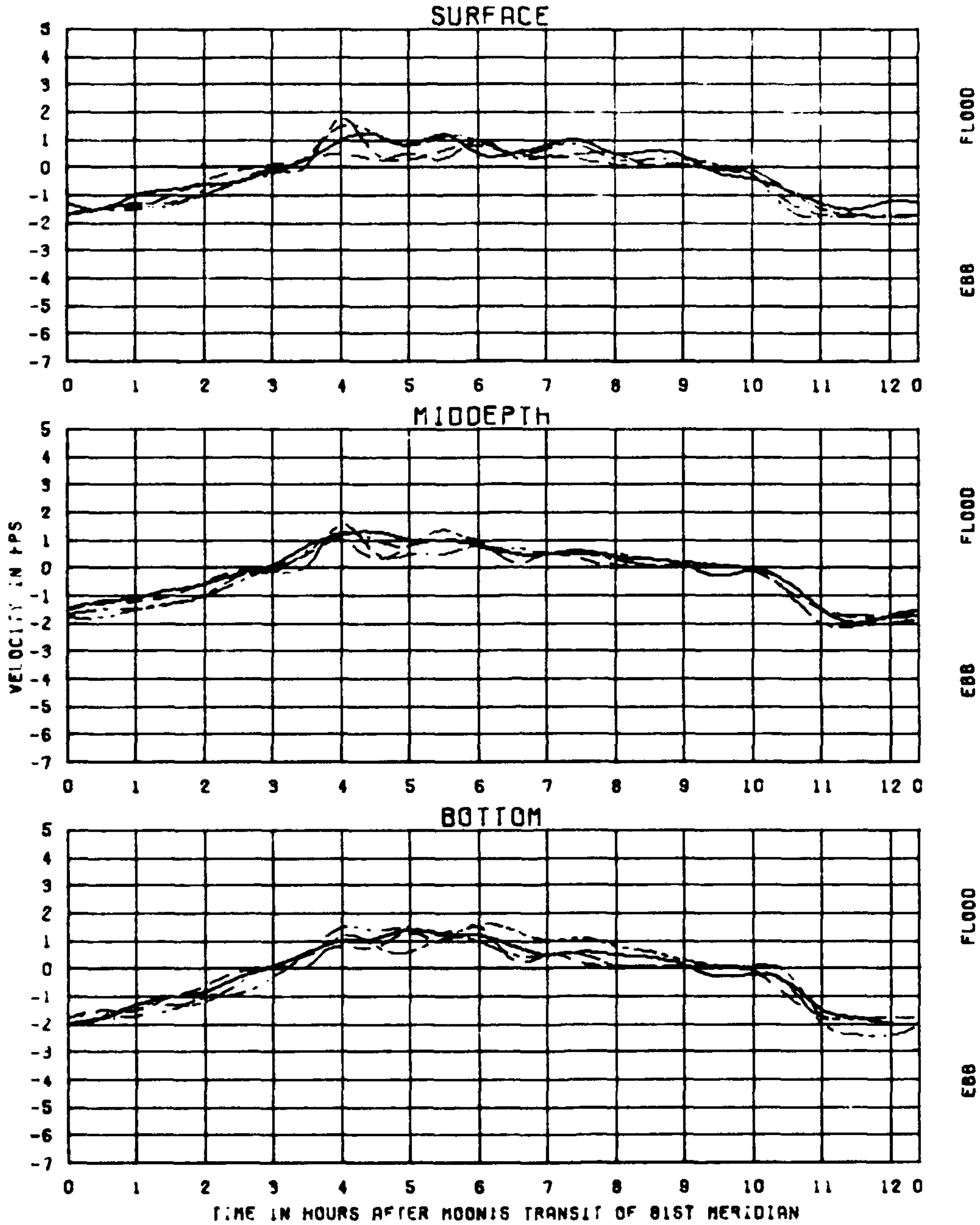
PLAN 6 —·—

PLAN 7 —·· —

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1989



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

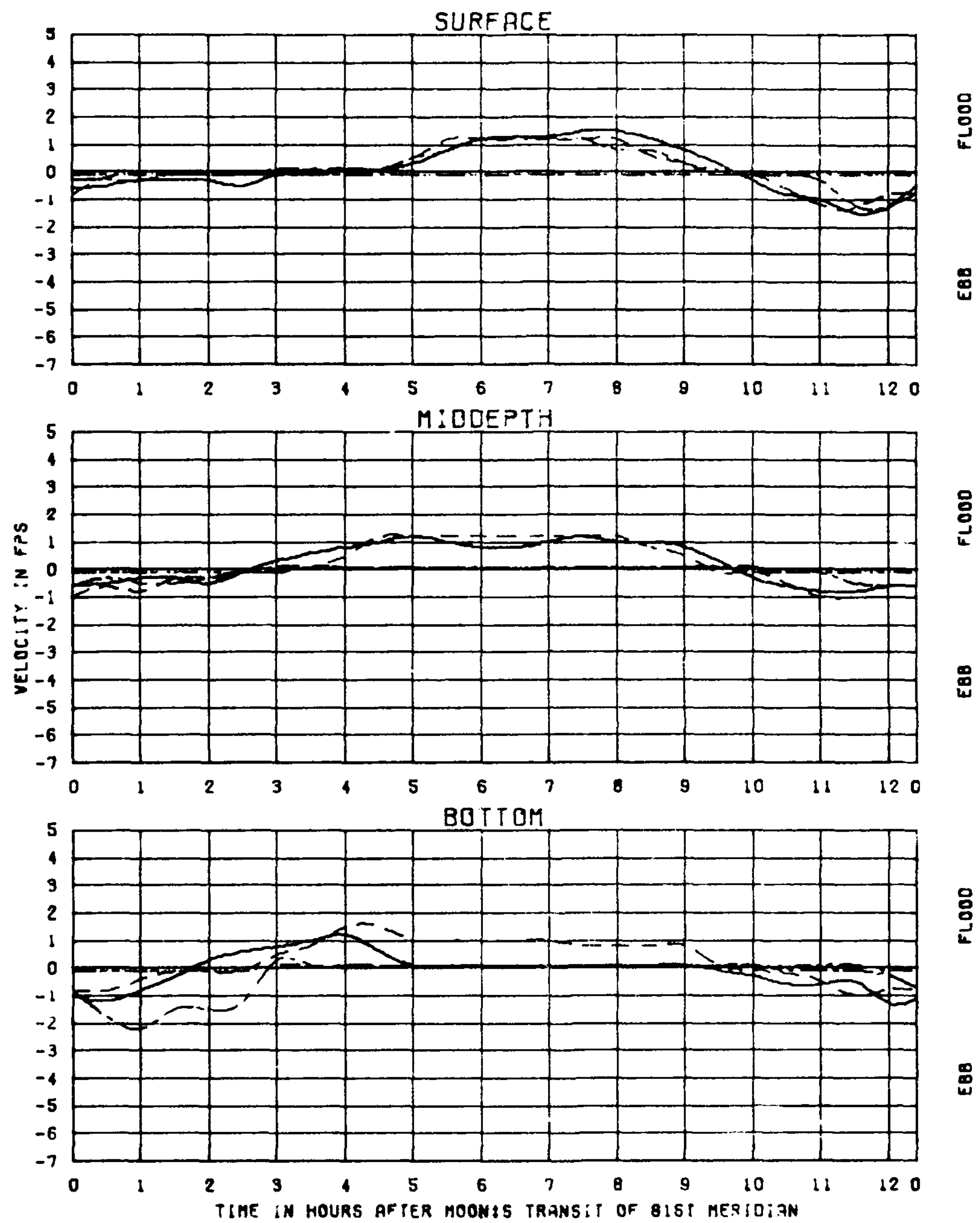
LEGEND

BASE ———
PLAN 5 — — —
PLAN 6 —-—
PLAN 7 —-·—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 1999



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

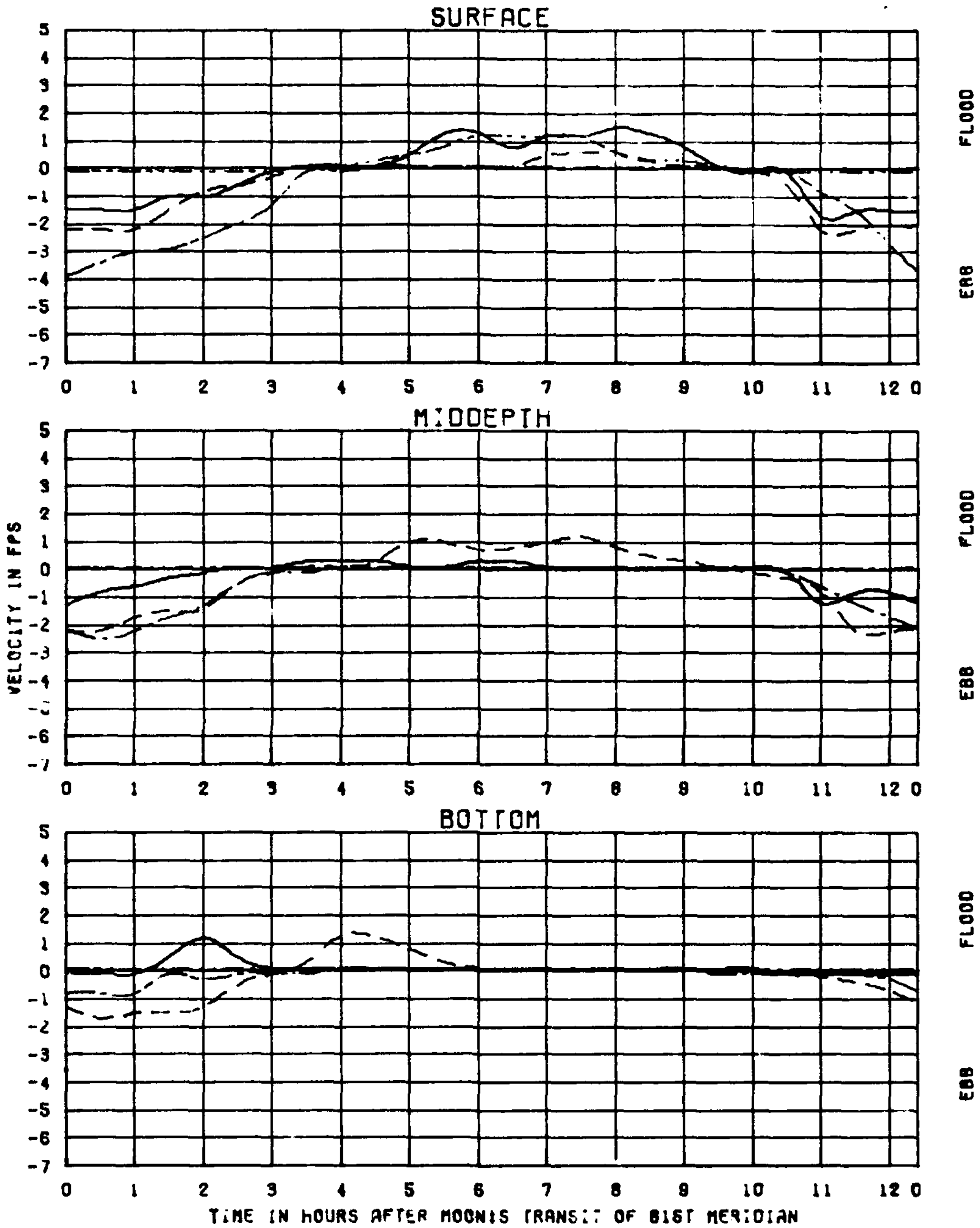
LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —· —
PLAN 7 —·· —

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 2074



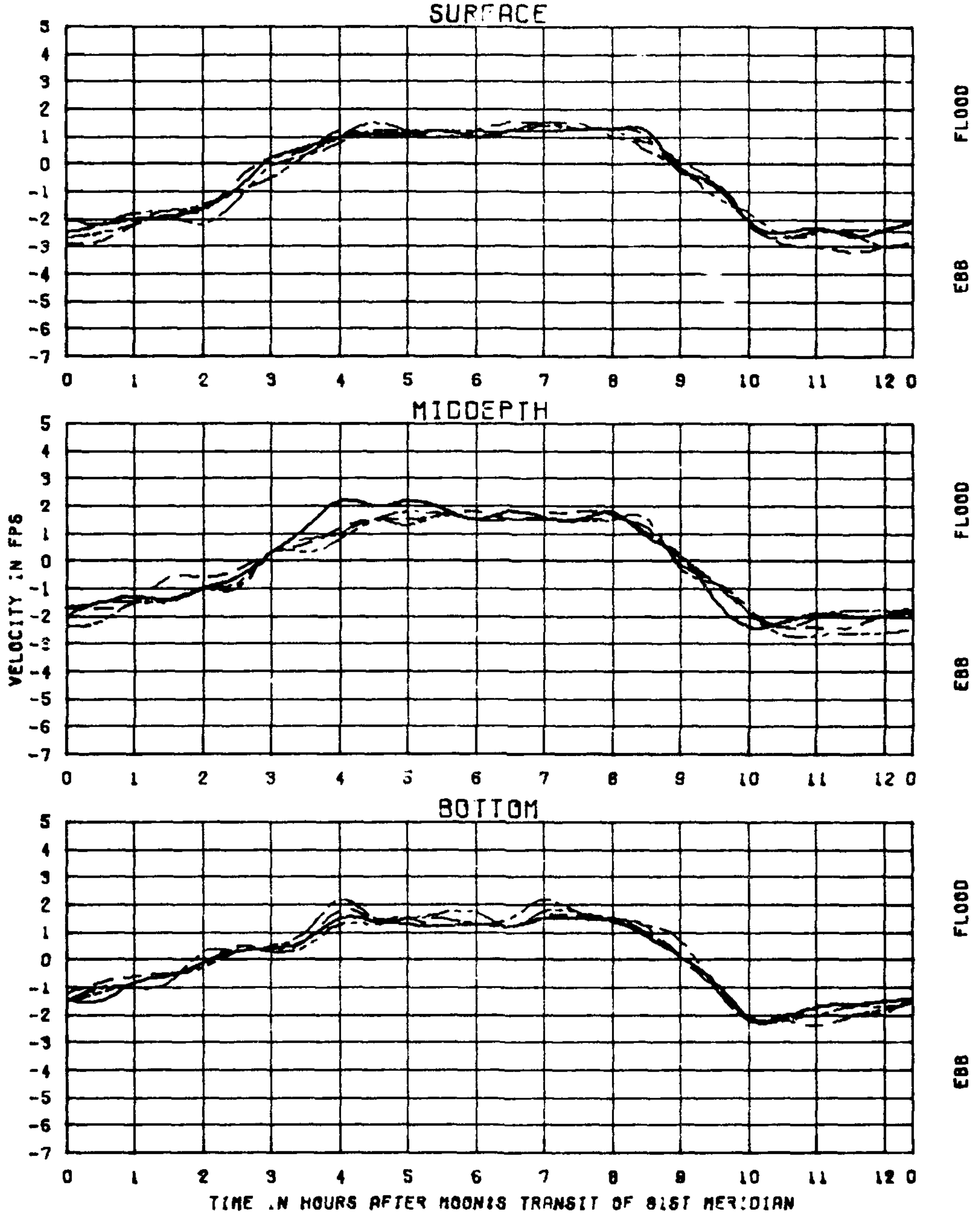
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 — · · —

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
2089



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

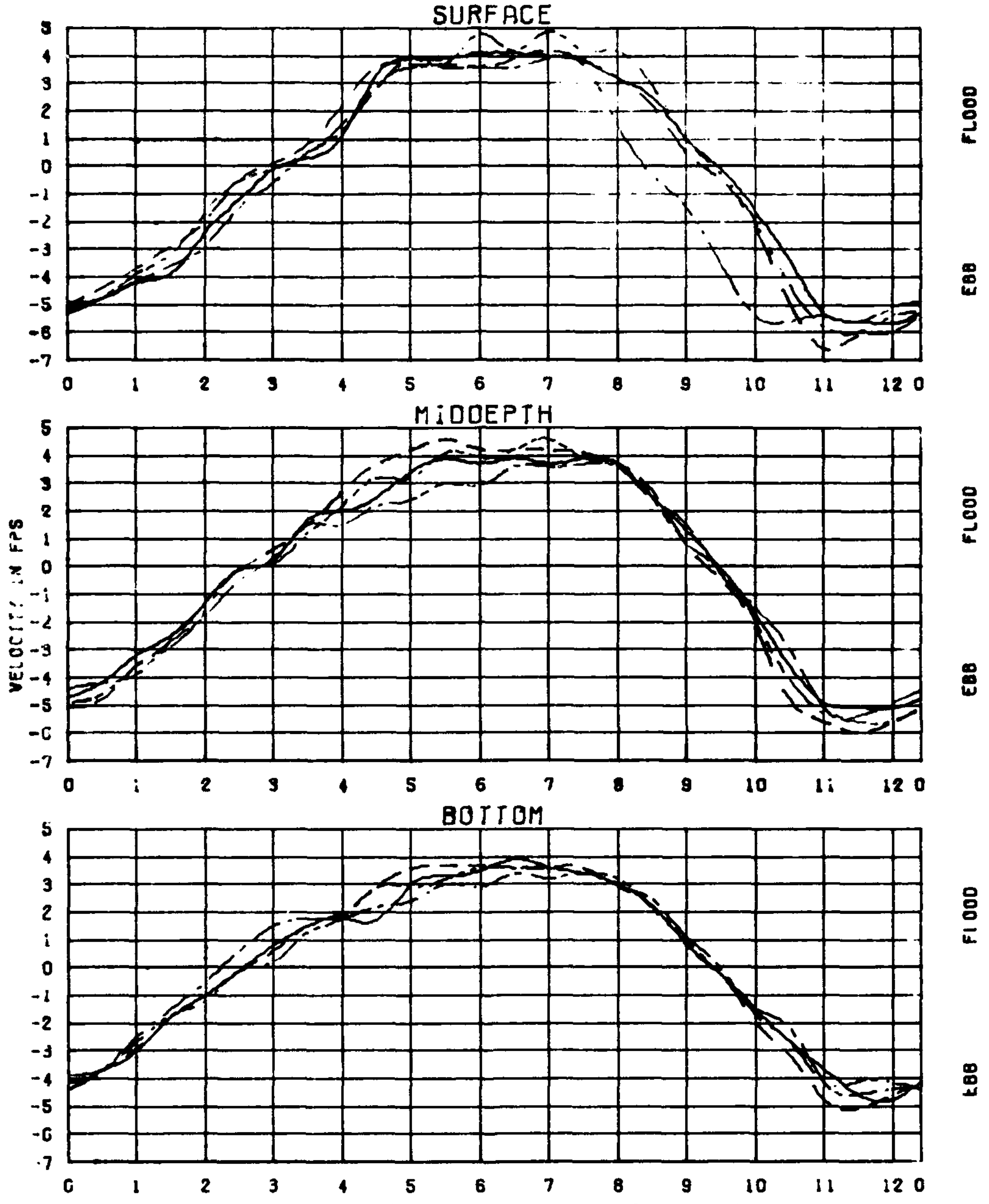
LEGEND

BASE	———
PLAN 5	— — —
PLAN 6	—·—
PLAN 7	—··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 2120



TEST CONDITIONS

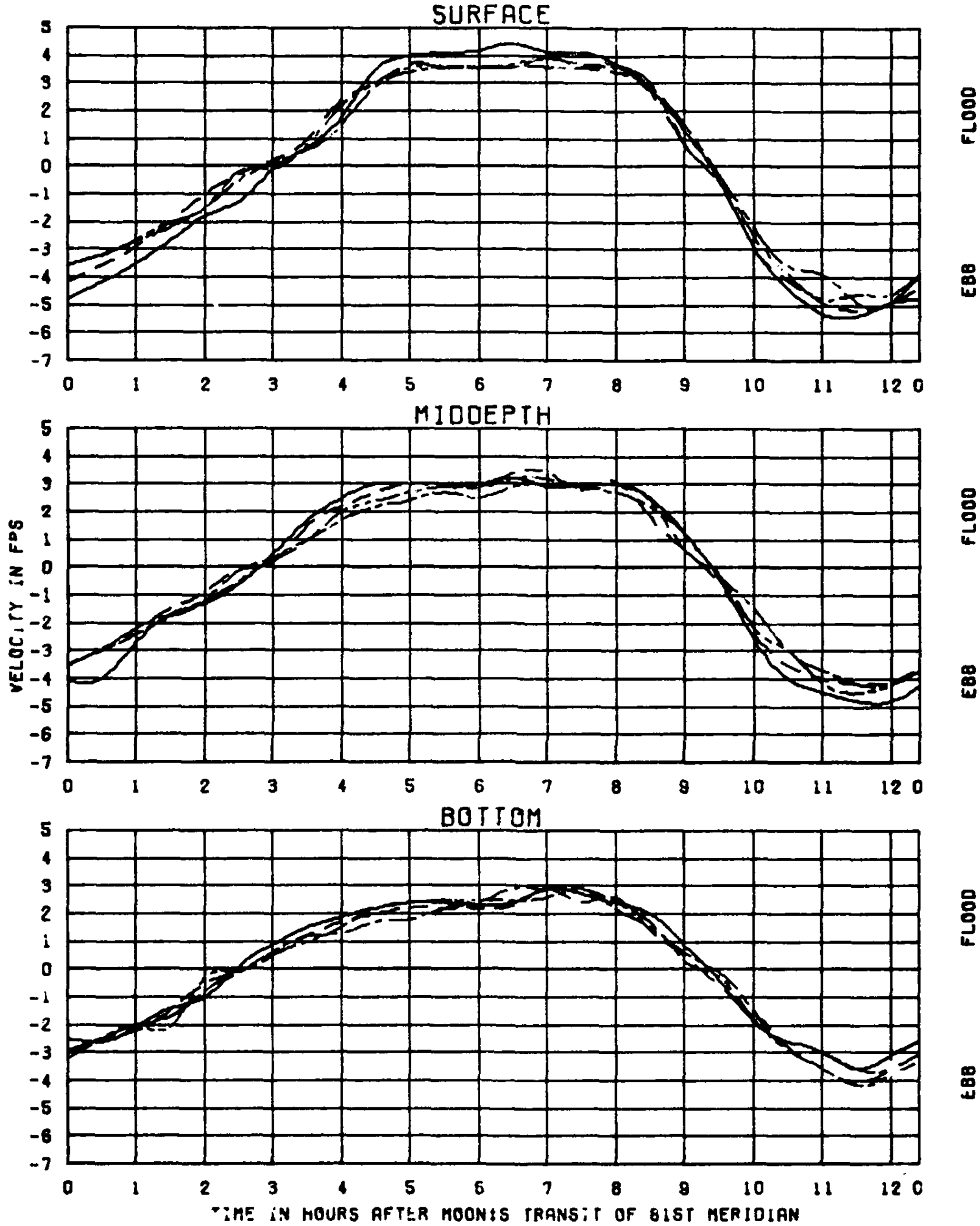
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —···—

KINGS BAY MODEL

EFFECTS OF PLANS P4-5, P4-6, AND P4-7 ON VELOCITIES

STATION 2122



TEST CONDITIONS

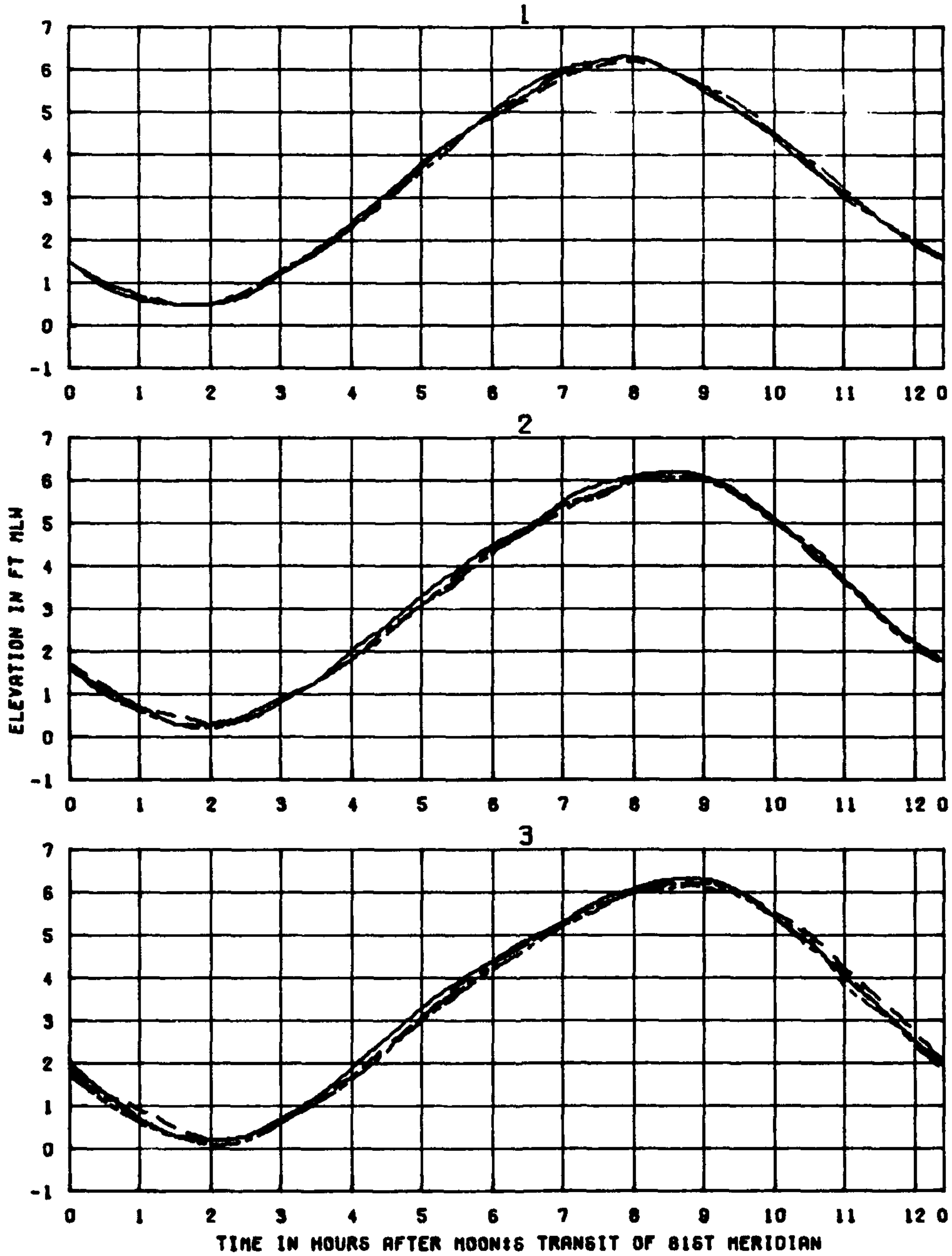
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ————
PLAN 5 — — —
PLAN 6 —·—
PLAN 7 —··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-5, P4-6, AND P4-7
ON VELOCITIES
STATION
2124



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

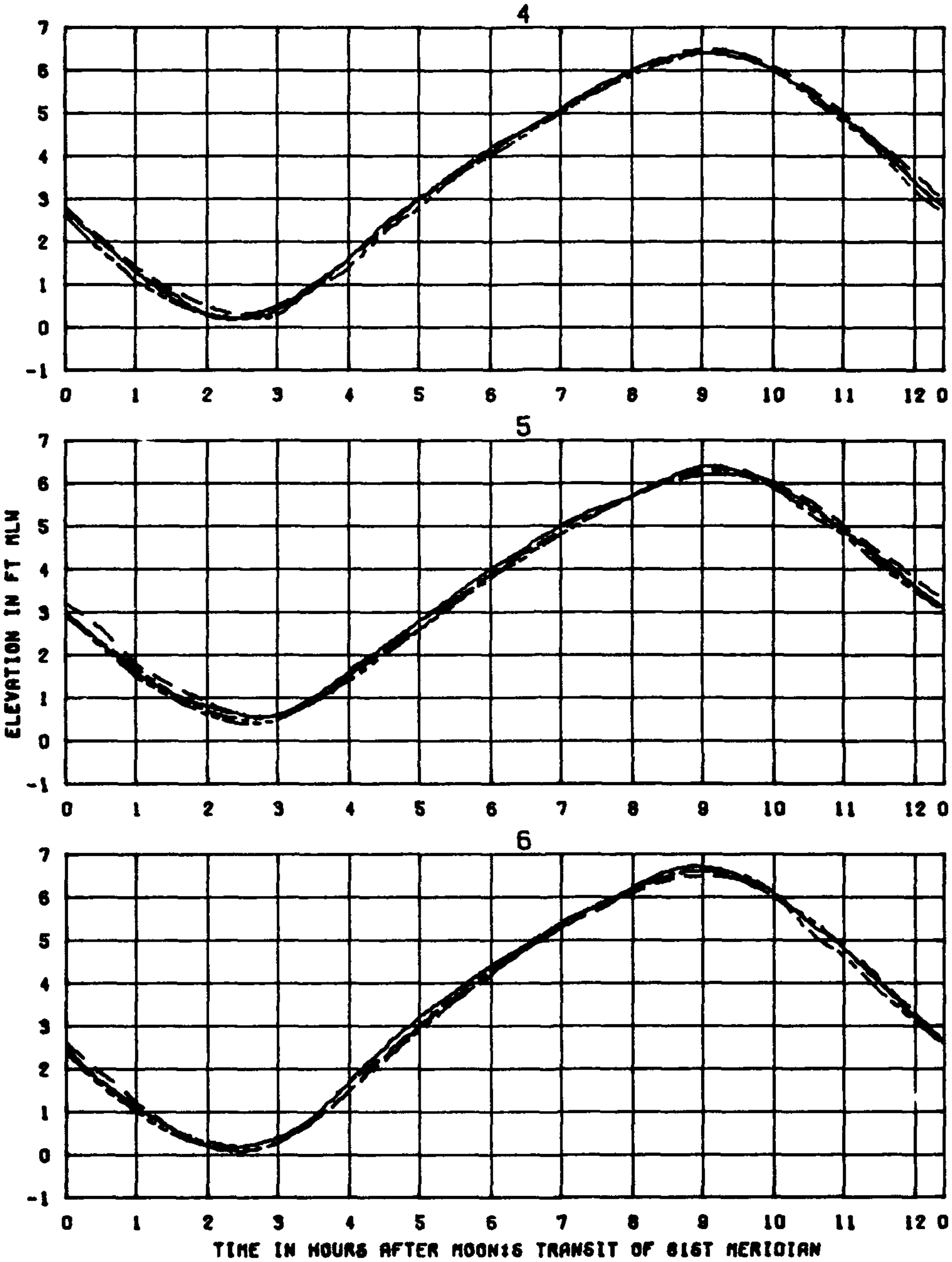
LEGEND

BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 —·-·—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON TIDAL HEIGHTS

STATIONS
1, 2, AND 3



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

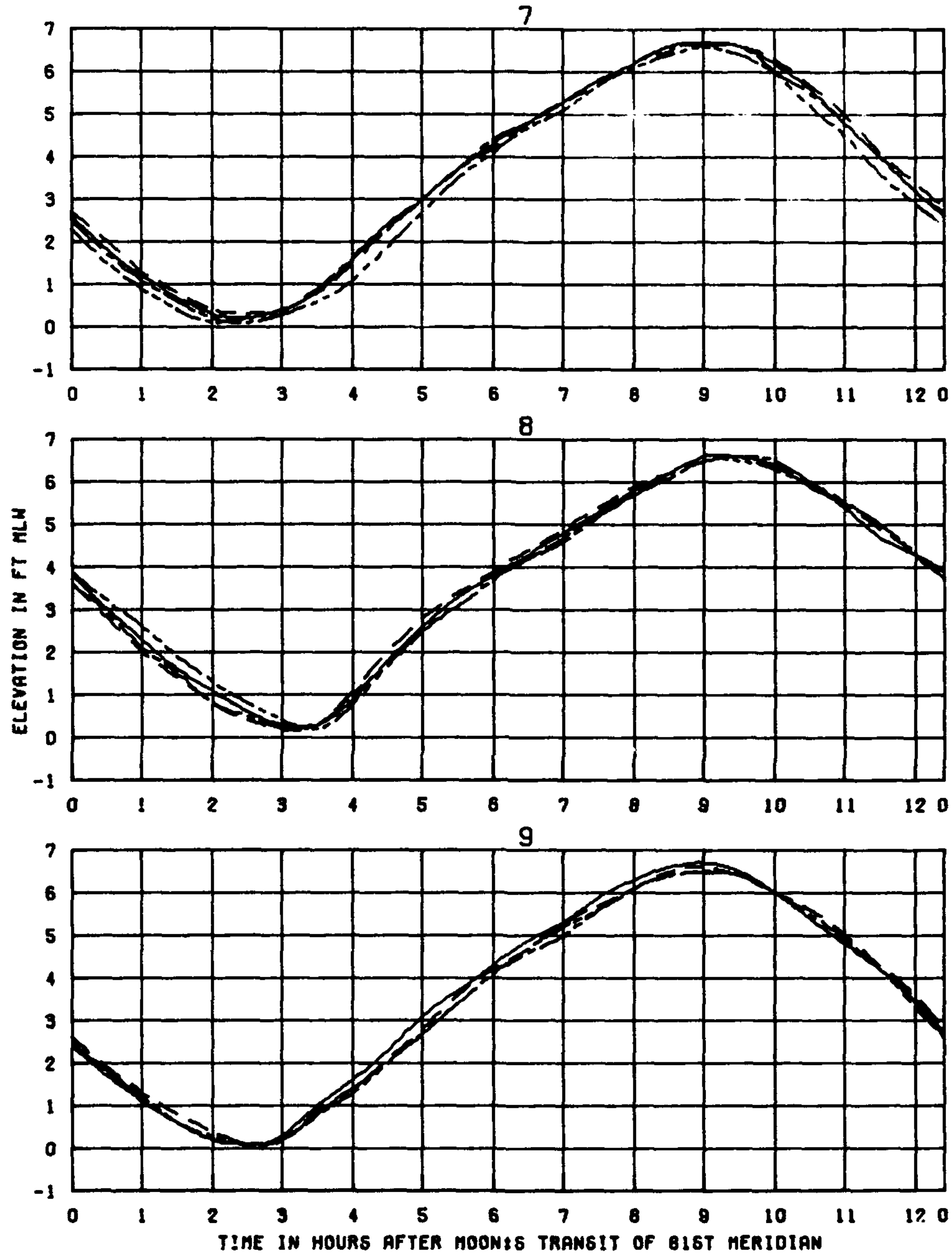
LEGEND

BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON TIDAL HEIGHTS

STATIONS 4, 5, AND 6



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

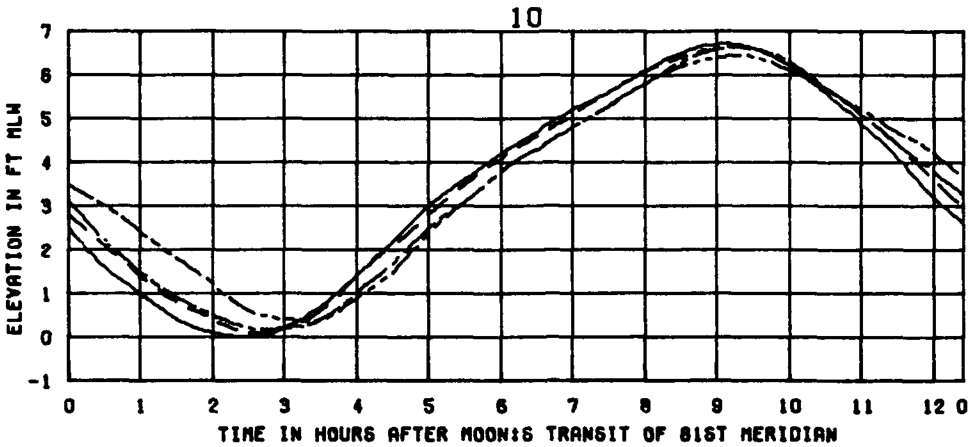
LEGEND

BASE
PLAN 8
PLAN 9
PLAN 10

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON TIDAL HEIGHTS

STATIONS
7, 8, AND 9



TEST CONDITIONS

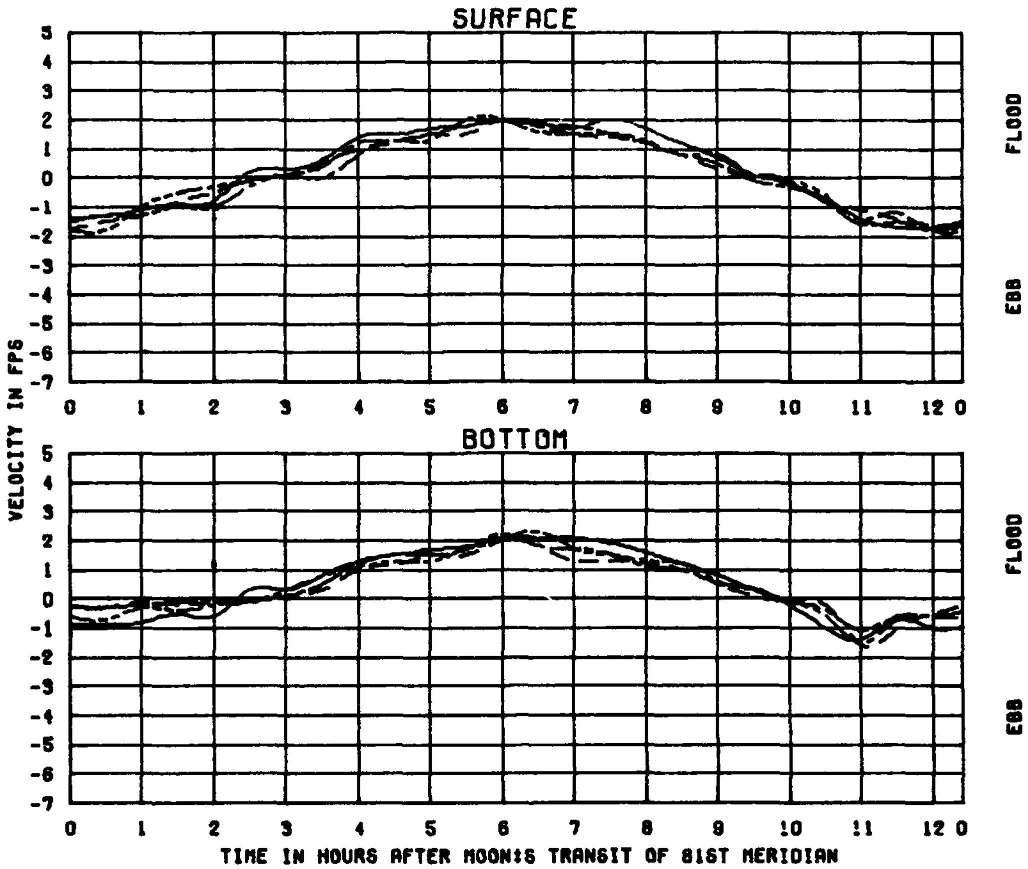
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-—
PLAN 10 -----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON TIDAL HEIGHTS

STATION 10



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———

PLAN 8 — — —

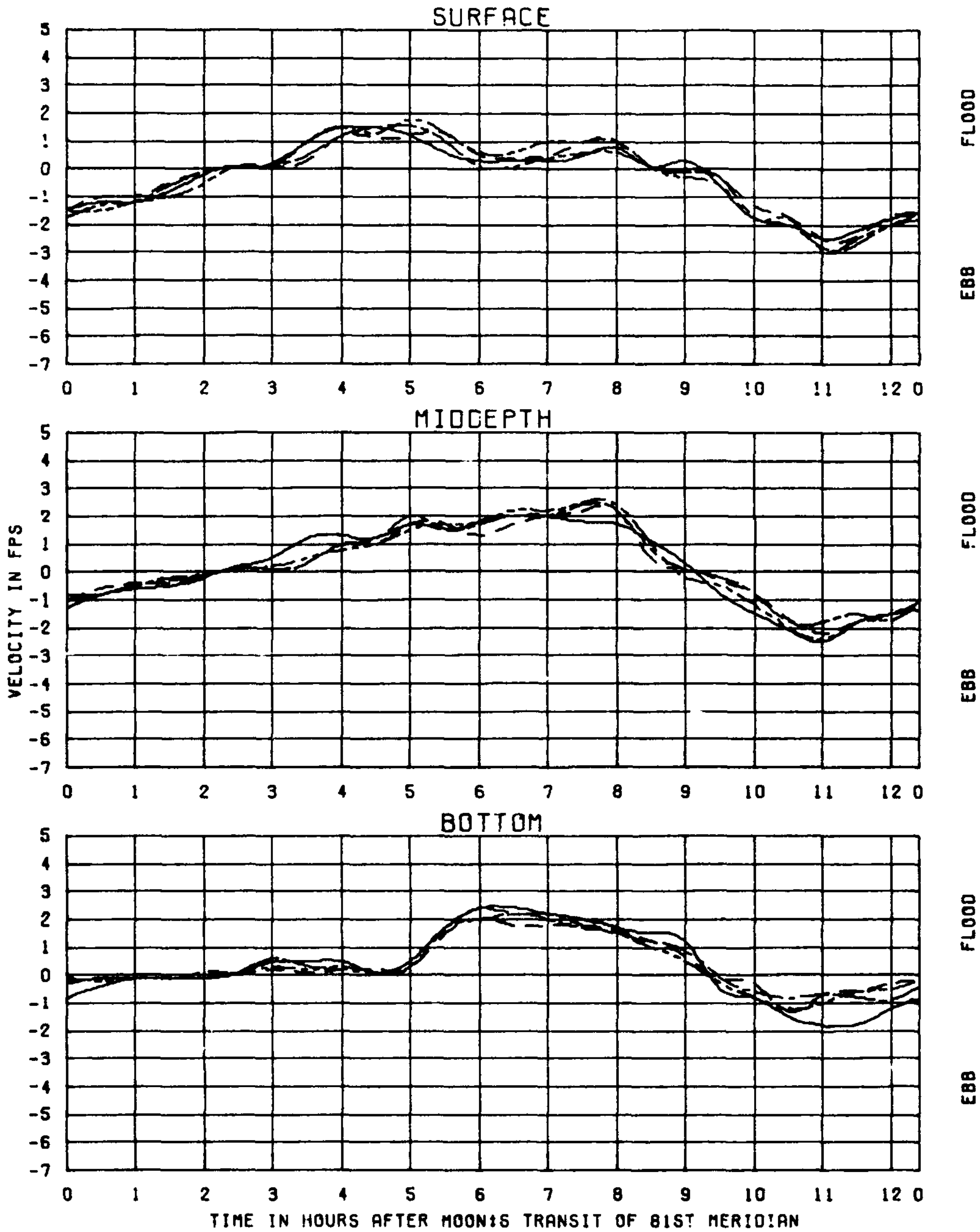
PLAN 9 —·—·—

PLAN 10 —-—-—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 20



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

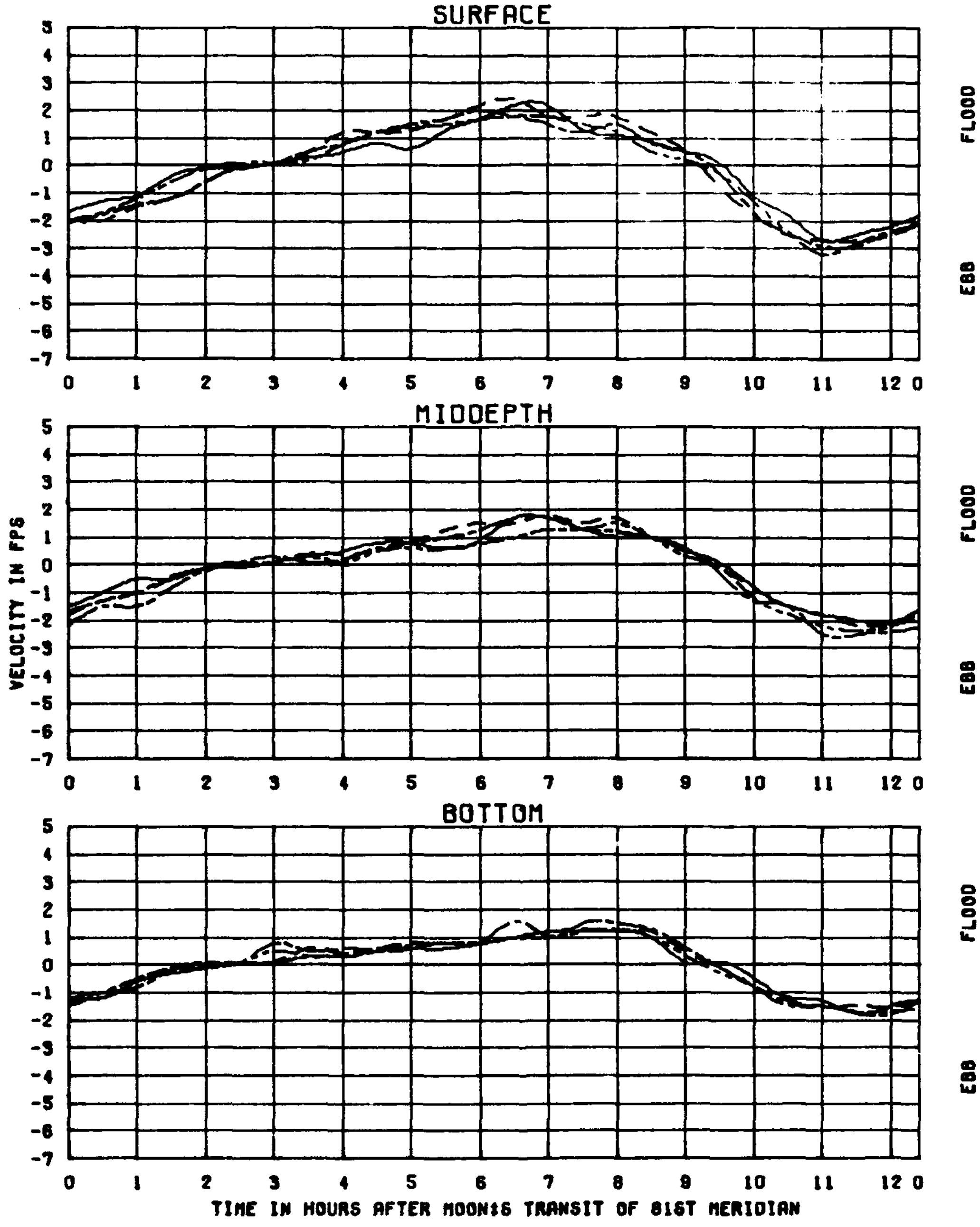
KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 50

LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —-—
PLAN 10 -----



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

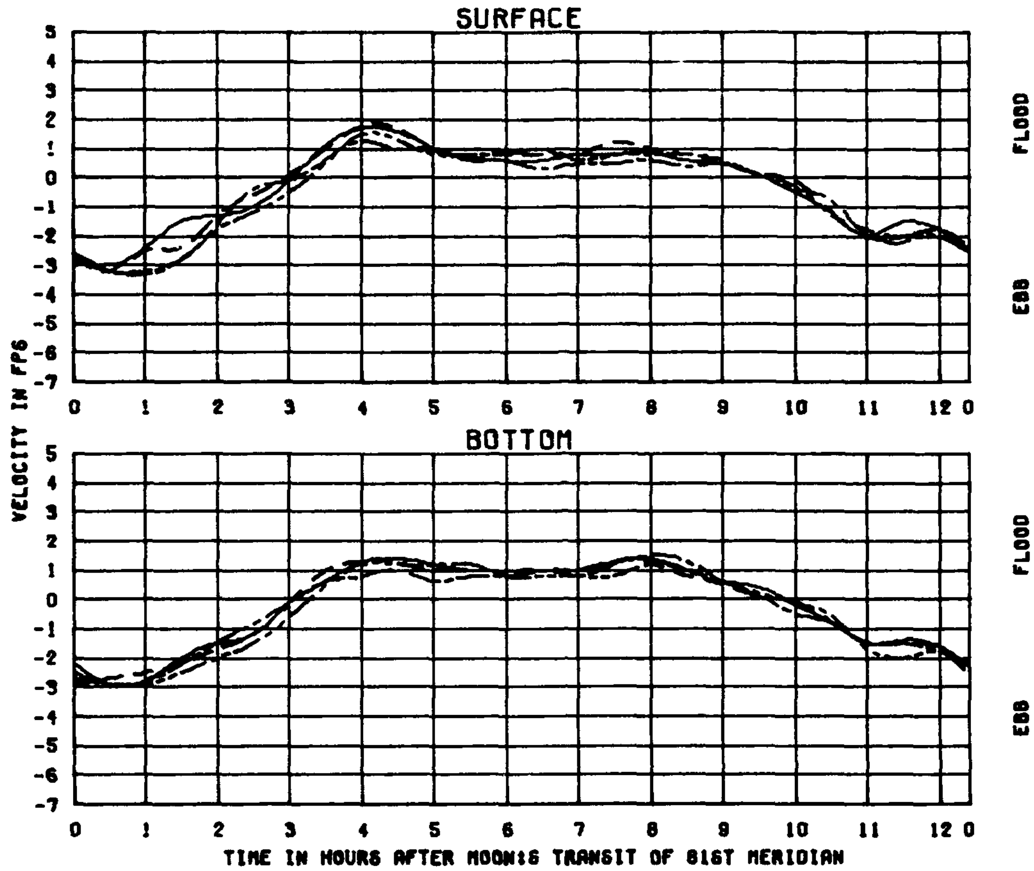
LEGEND

- BASE ————
- PLAN 8 — — —
- PLAN 9 —·—
- PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 60



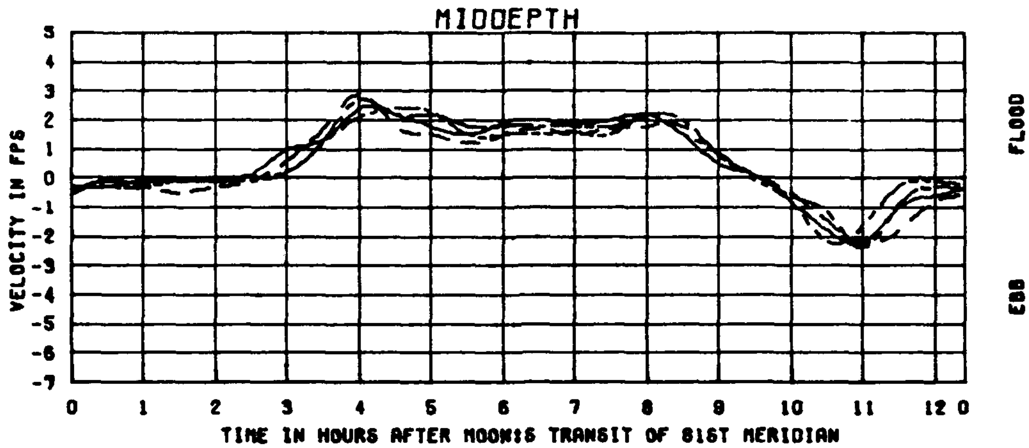
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
160

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 -----



TEST CONDITIONS

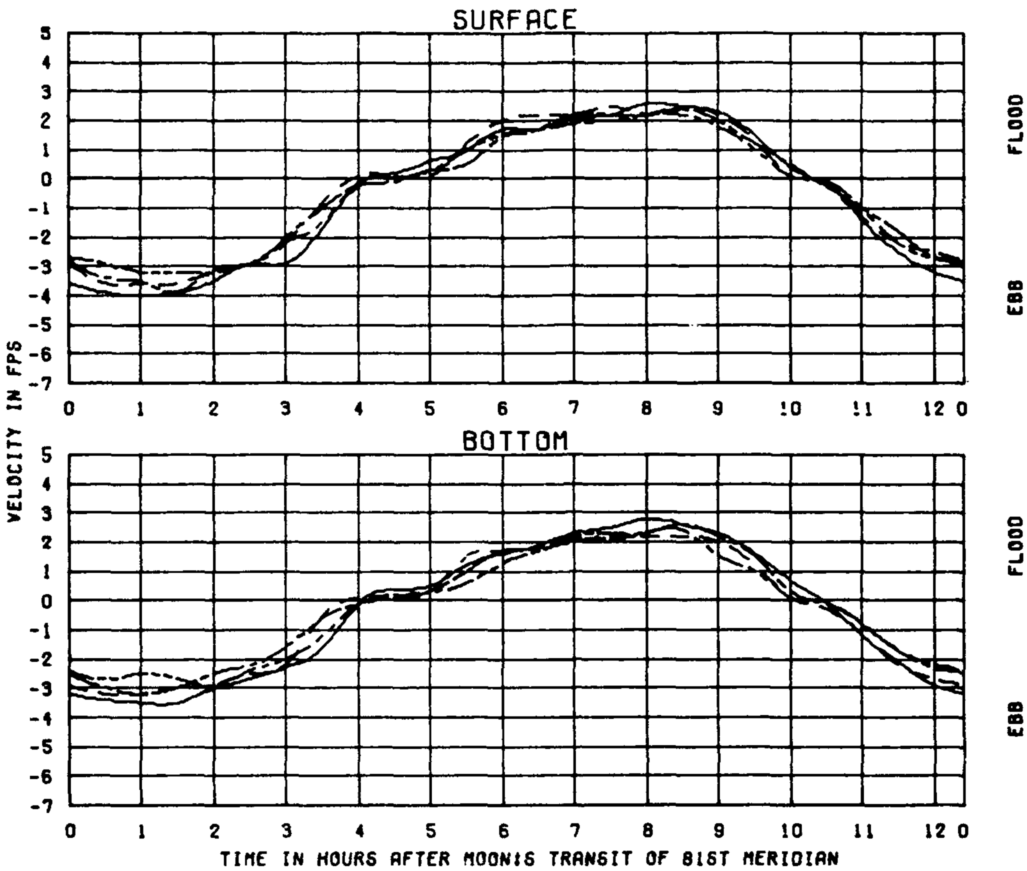
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —-·—
PLAN 10 —--—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8,P4-9,AND P4-10
ON VELOCITIES
STATION
180



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

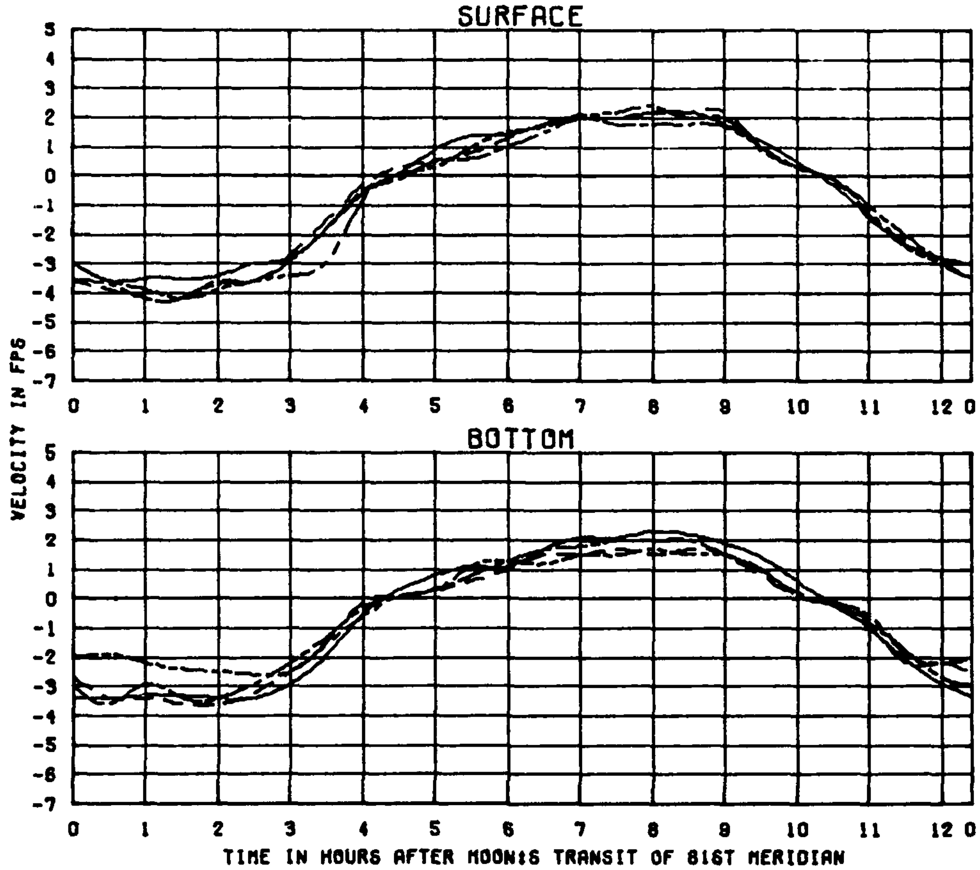
KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
230

LEGEND

BASE	———
PLAN 8	— — —
PLAN 9	—·—·—
PLAN 10	—··——



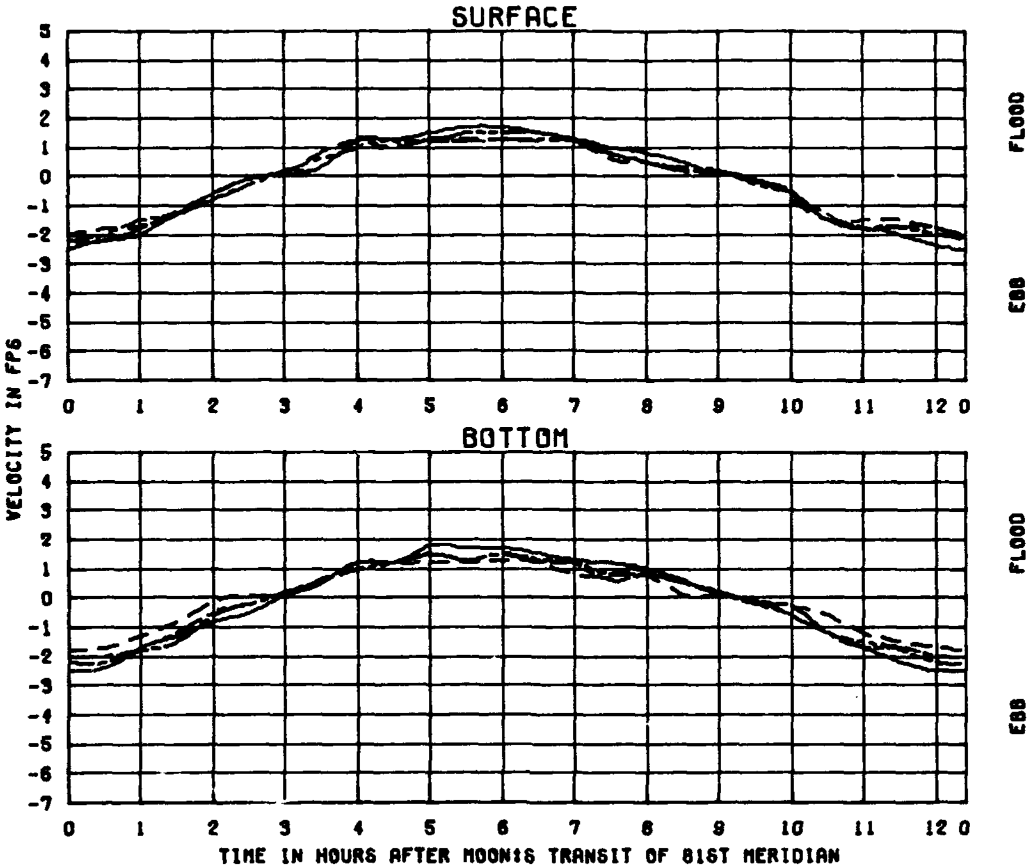
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
240



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

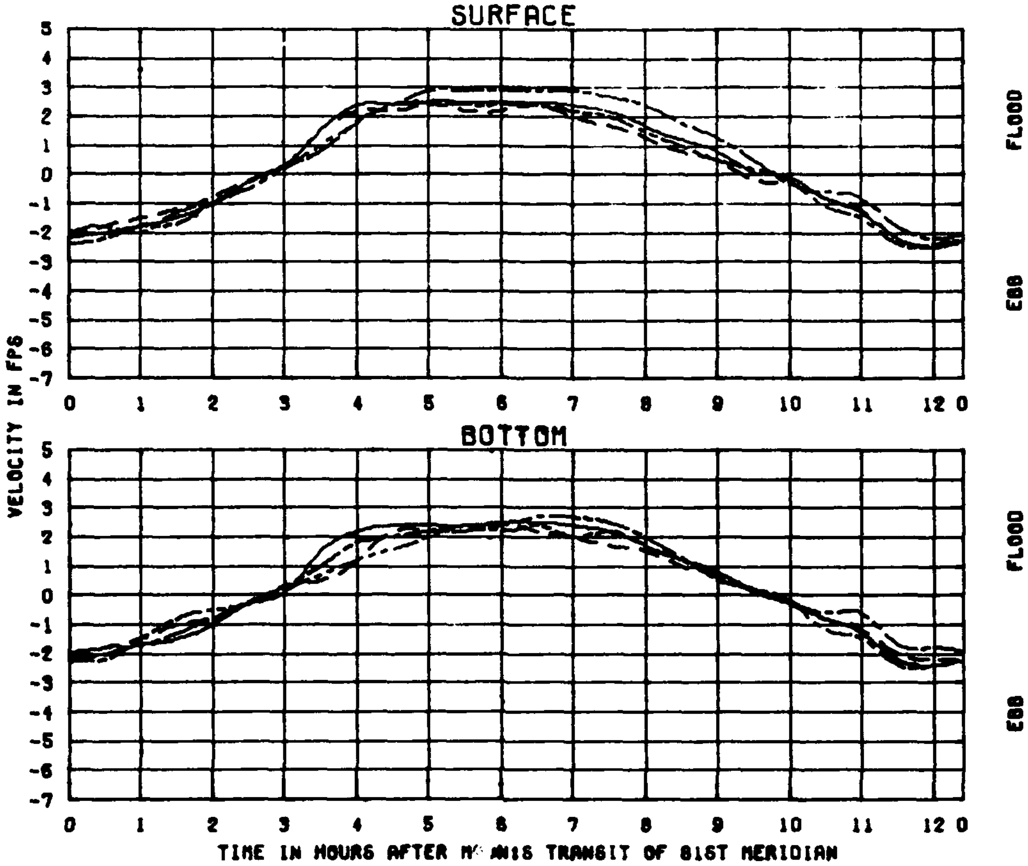
LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8,P4-9,AND P4-10 ON VELOCITIES

STATION 396



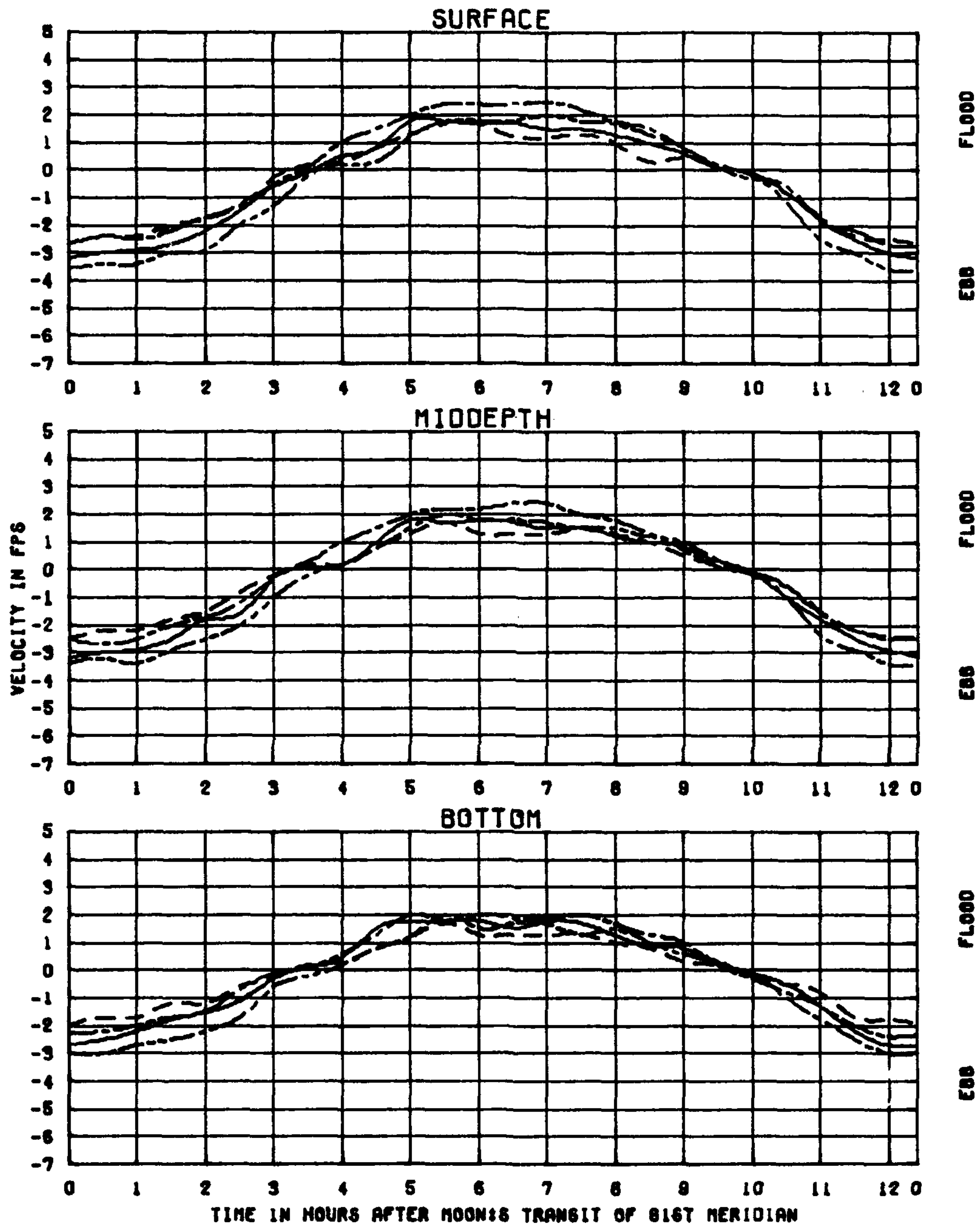
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 —···—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
5B4



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

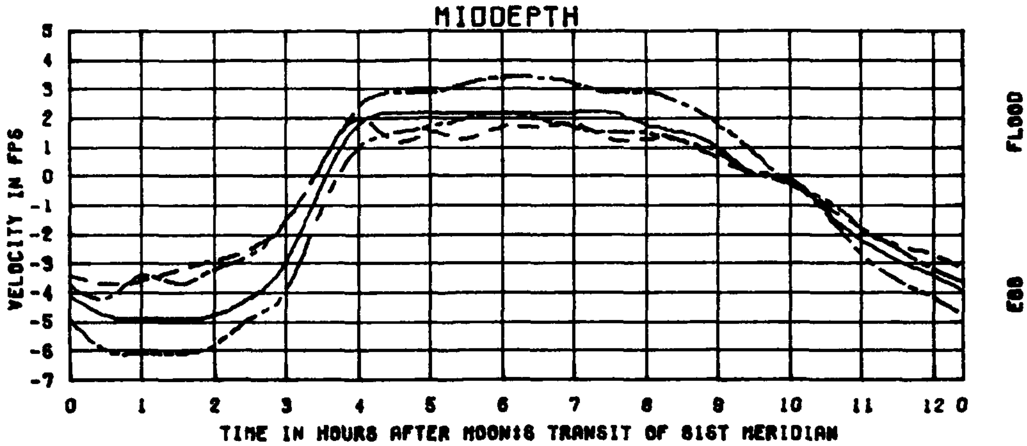
LEGEND

BASE	———
PLAN 8	— — —
PLAN 9	—·—
PLAN 10	-----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 650



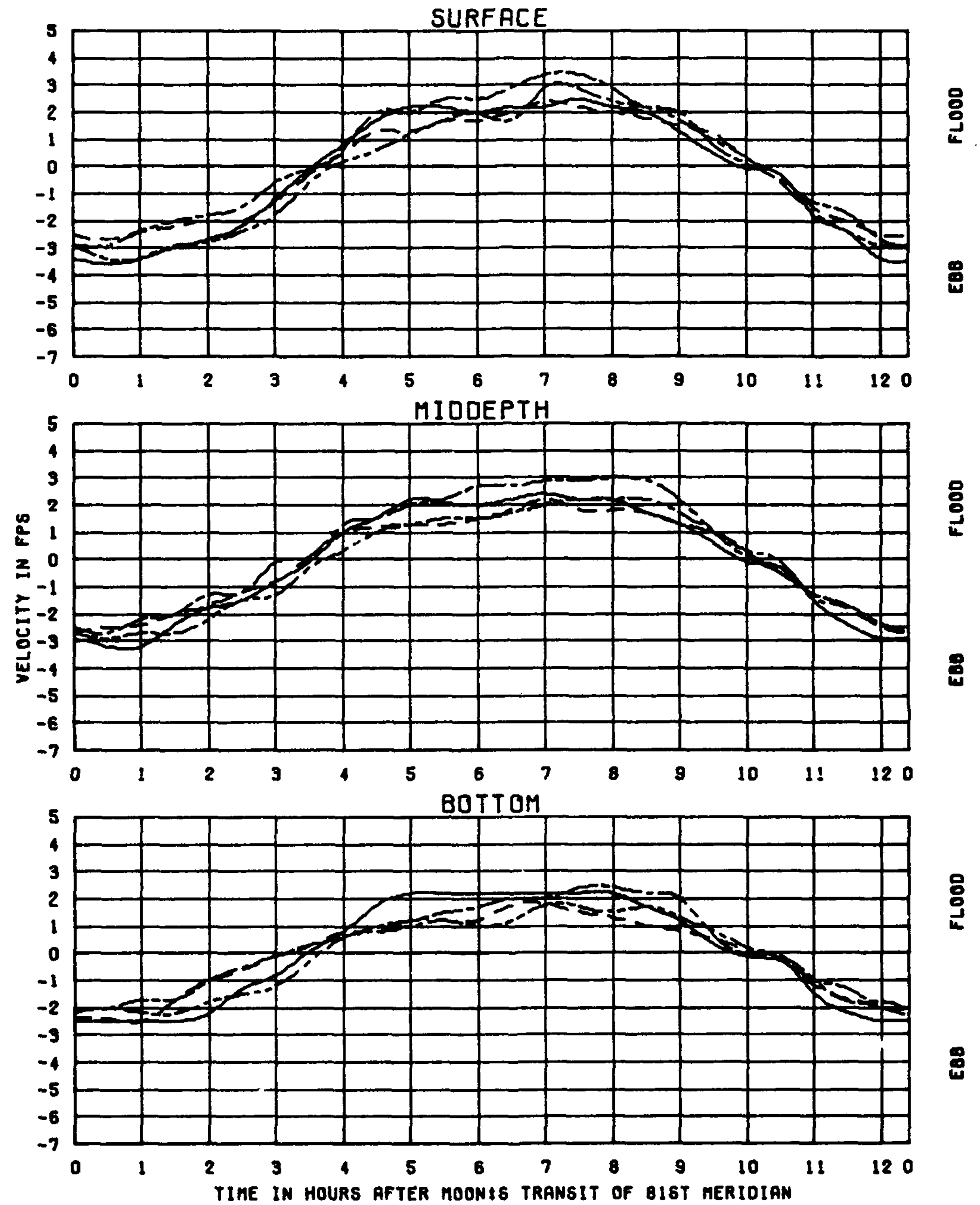
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-·—
PLAN 10 —-—-

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
812



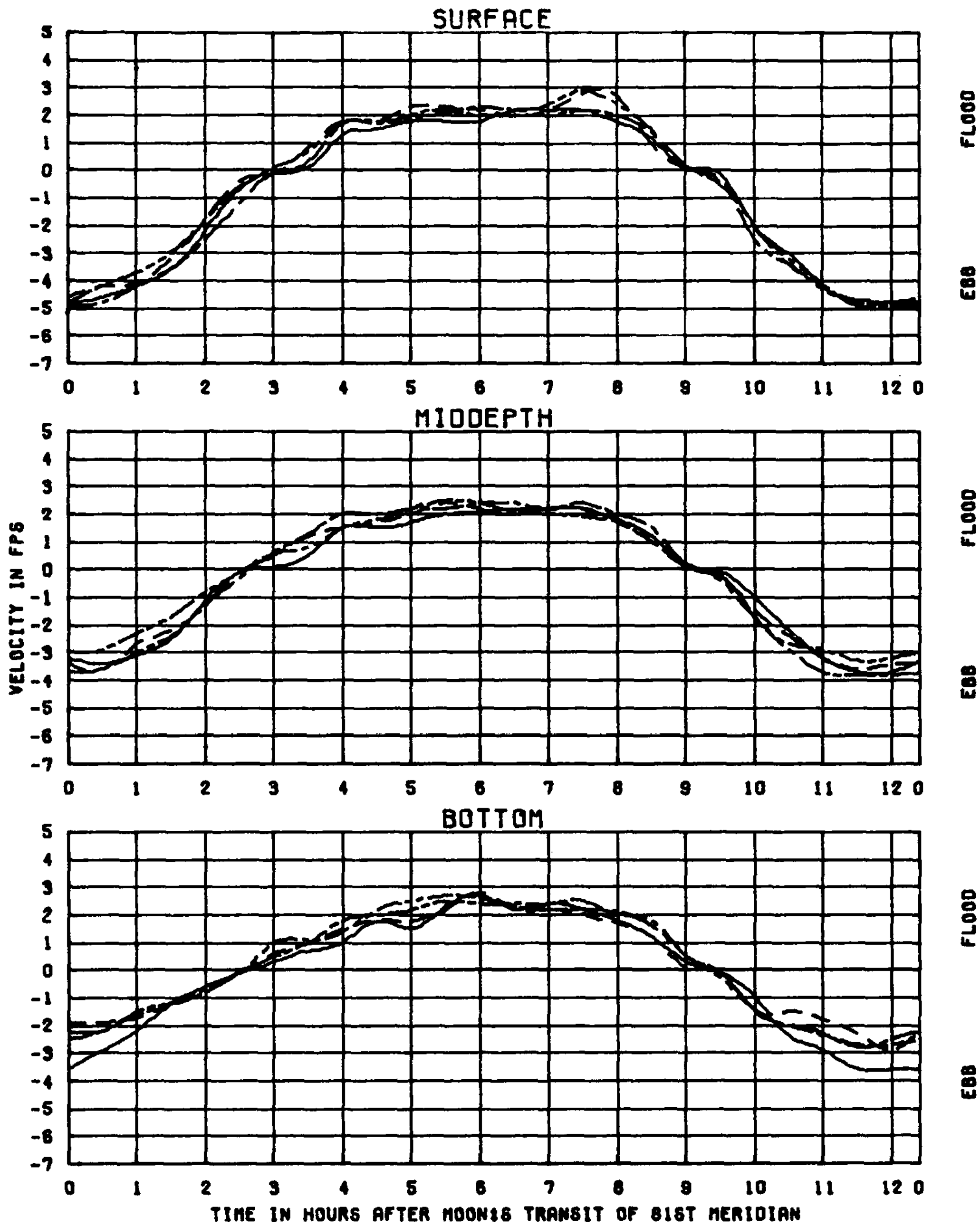
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

..'OS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 818

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 - - -
PLA.. 10 - · -



TEST CONDITIONS

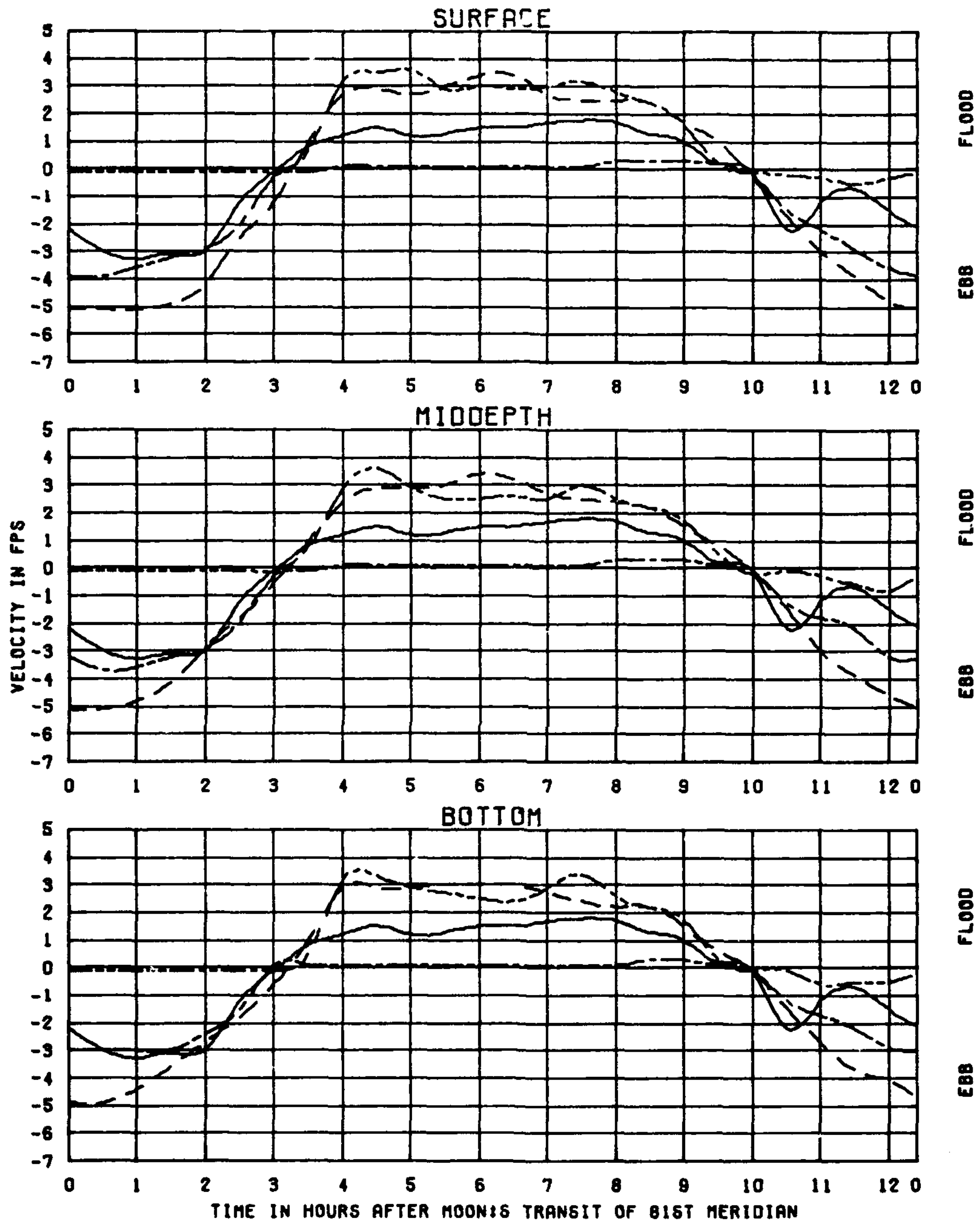
TIDE RANGE AT GAGE 1		5.8 FT
OCEAN SALINITY(TOTAL SALT)		32.5 PPT
FRESHWATER INFLOW		1100 CFS

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 843



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ————

PLAN 8 — — —

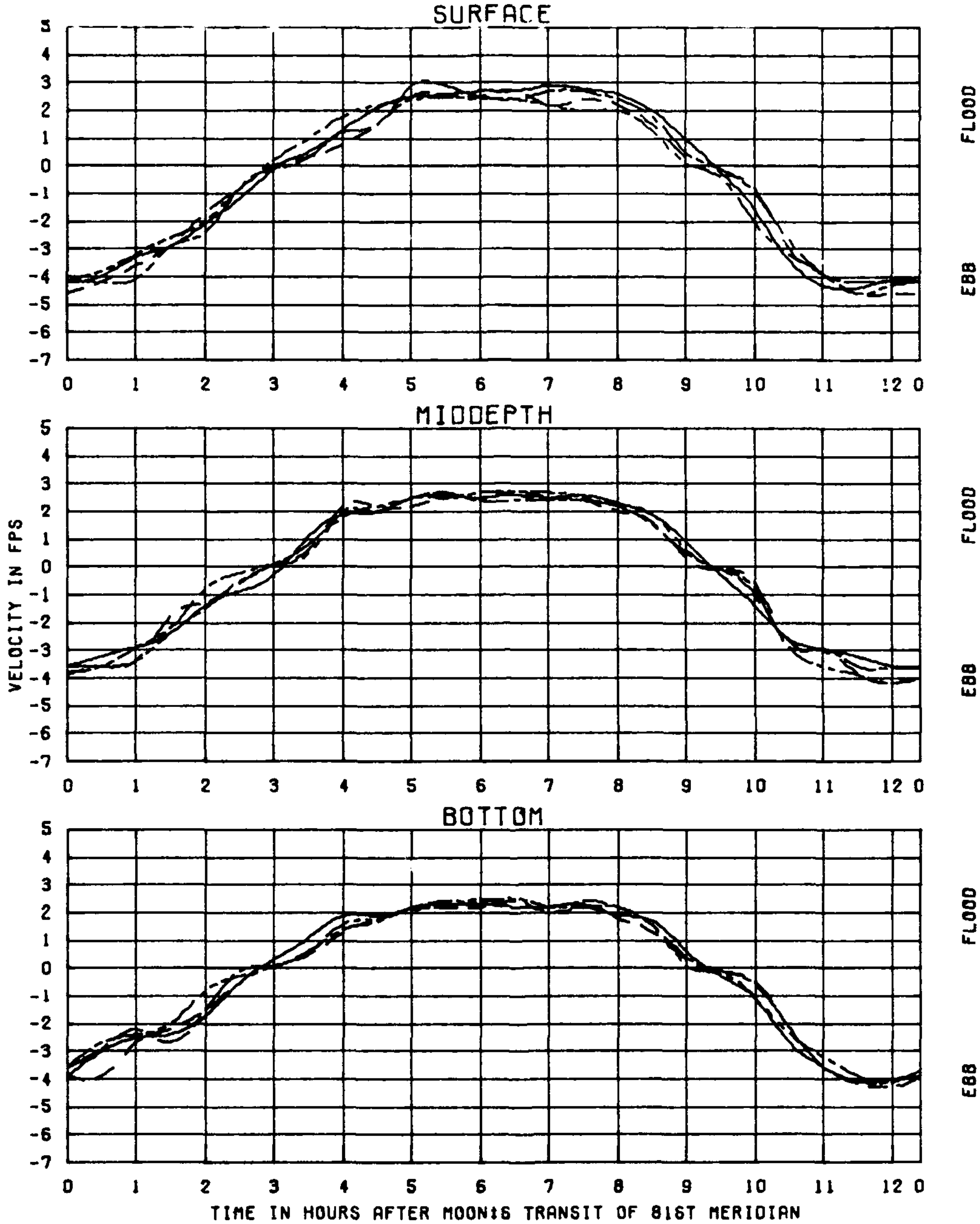
PLAN 9 —·—

PLAN 10 —--—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1014



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

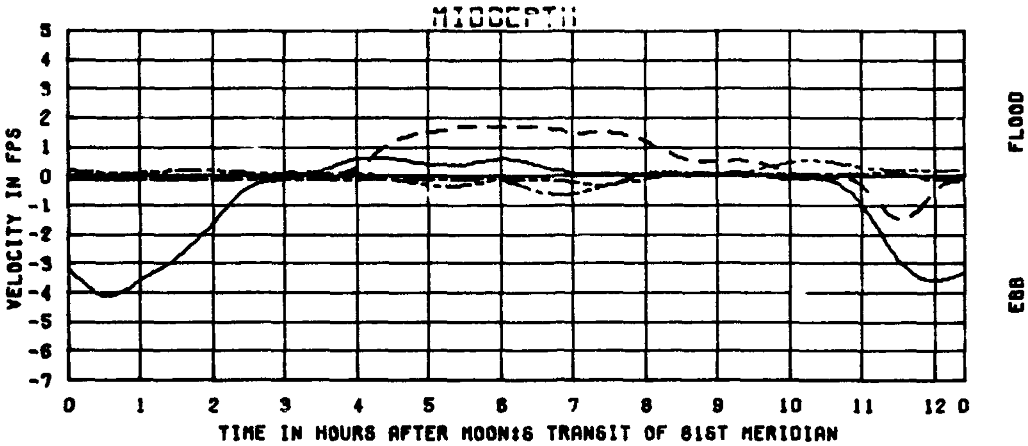
LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 -----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1055



TEST CONDITIONS

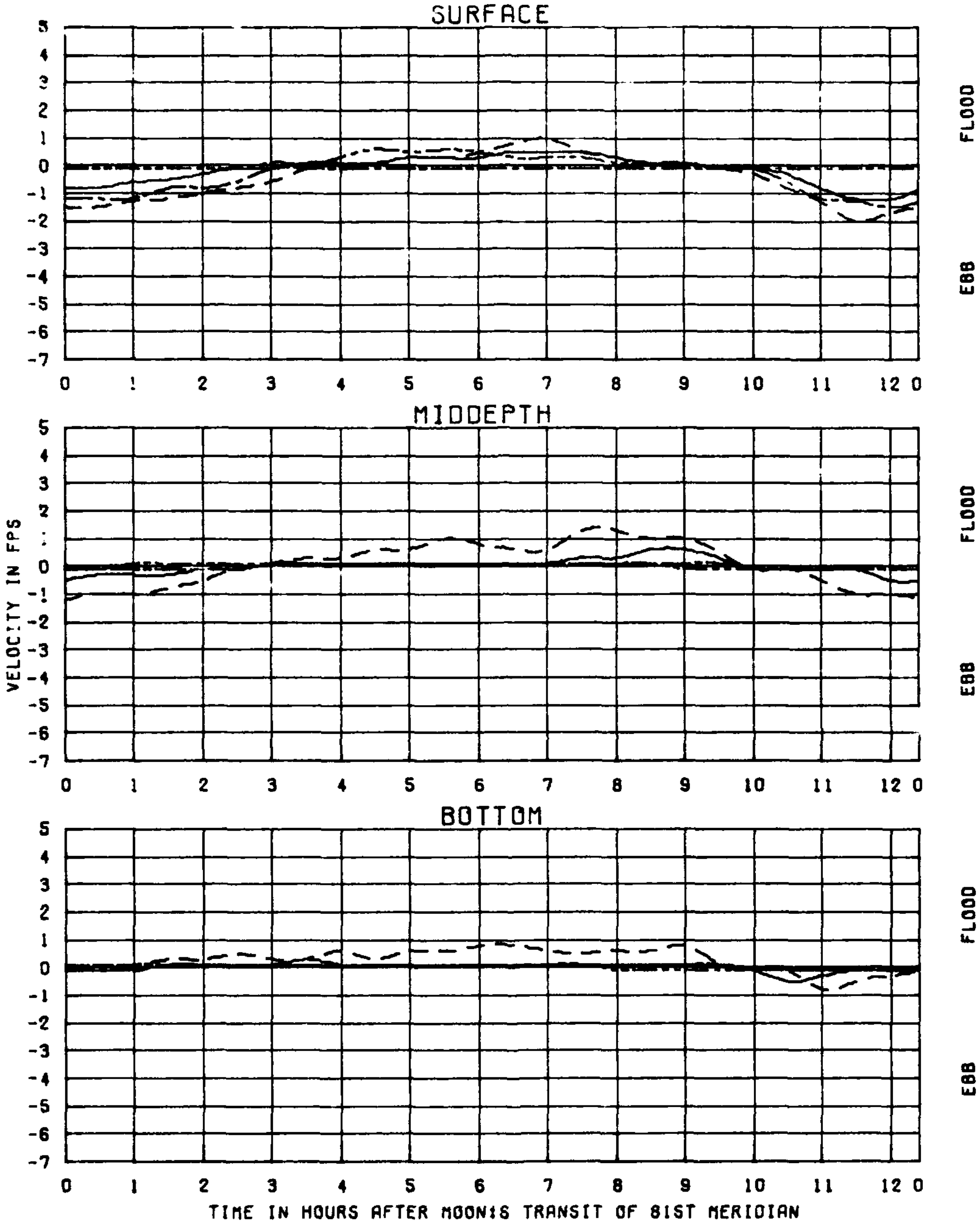
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
1066



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

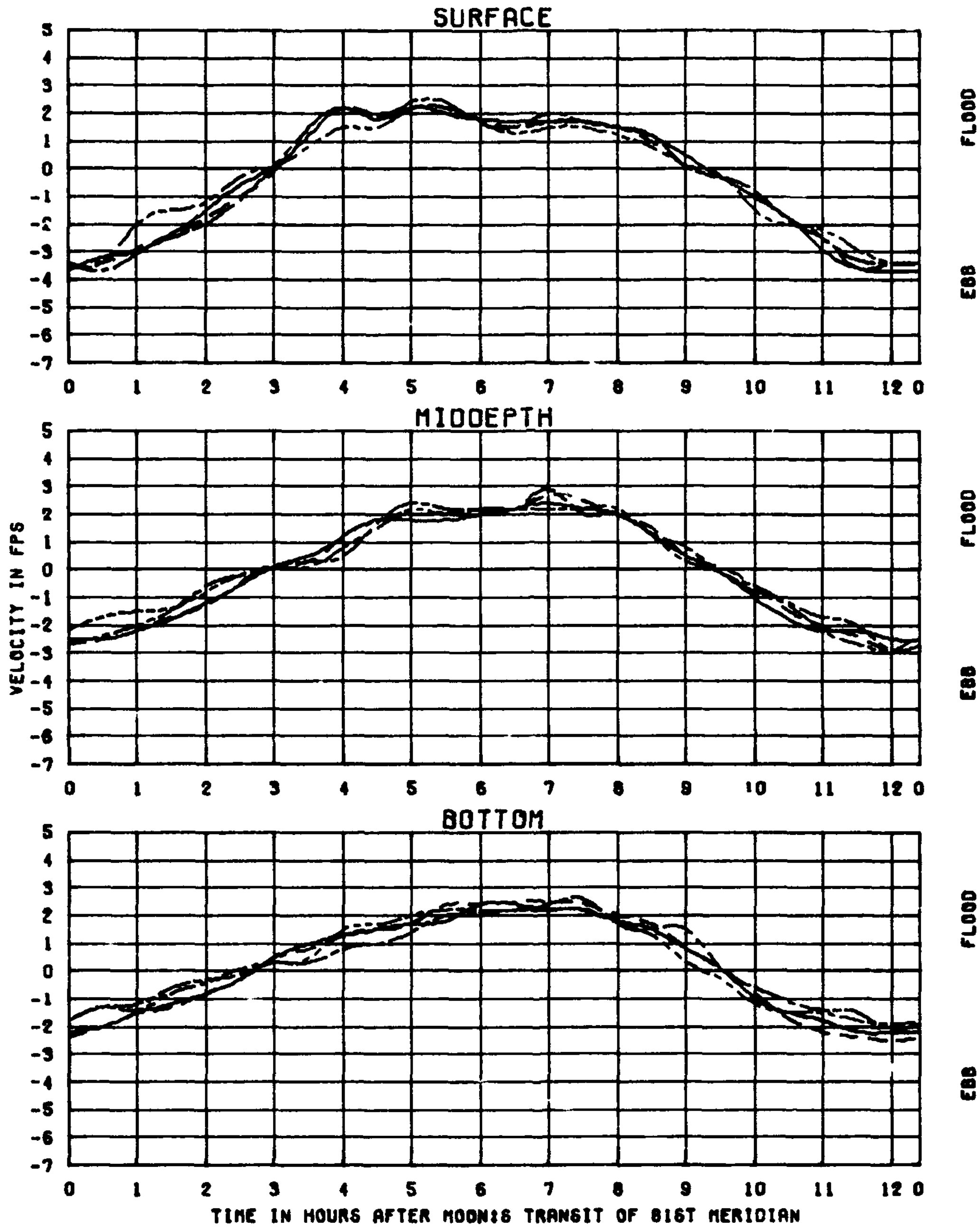
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ---—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION

1142



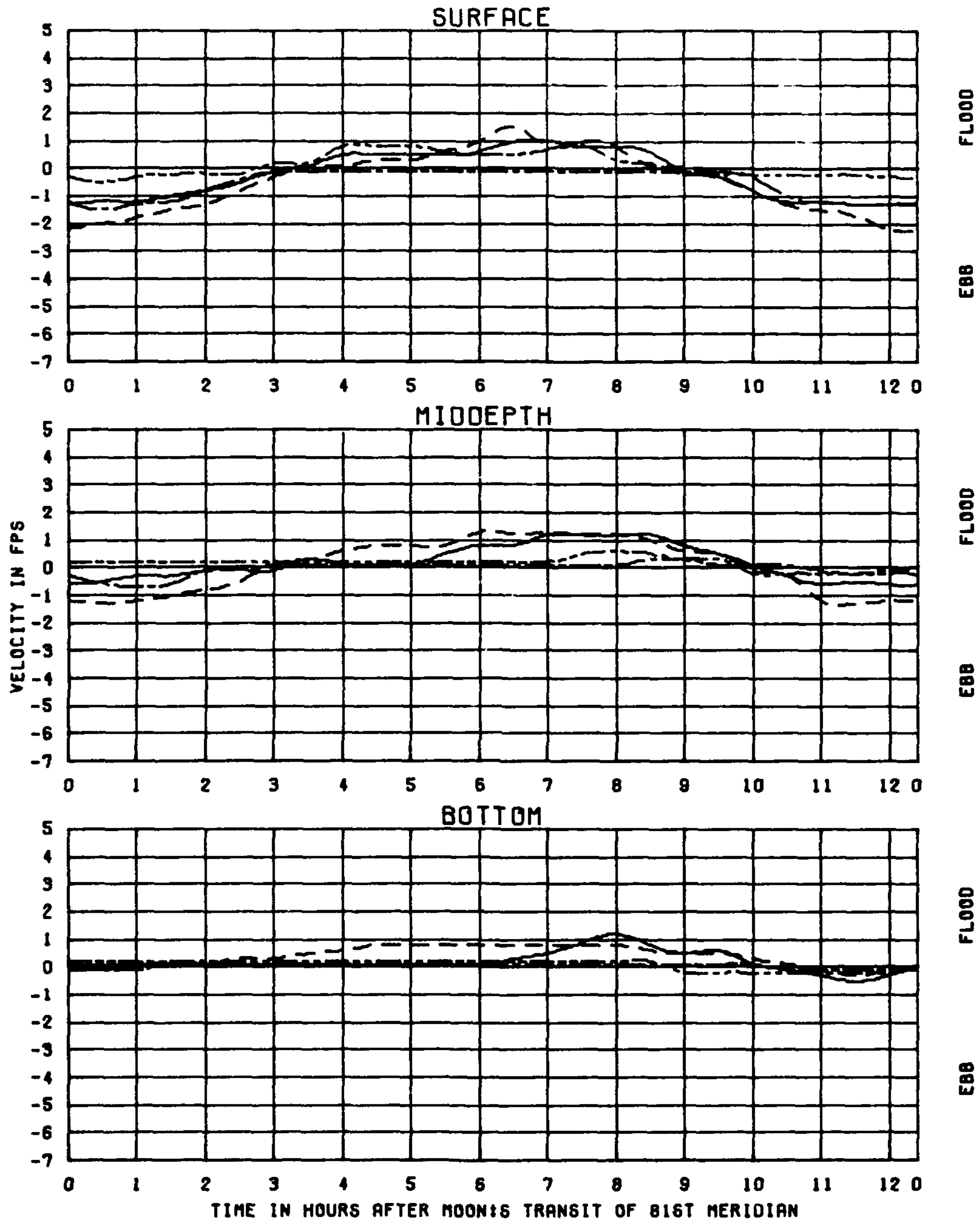
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—·—
PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1153



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND

BASE ———

PLAN 8 — — —

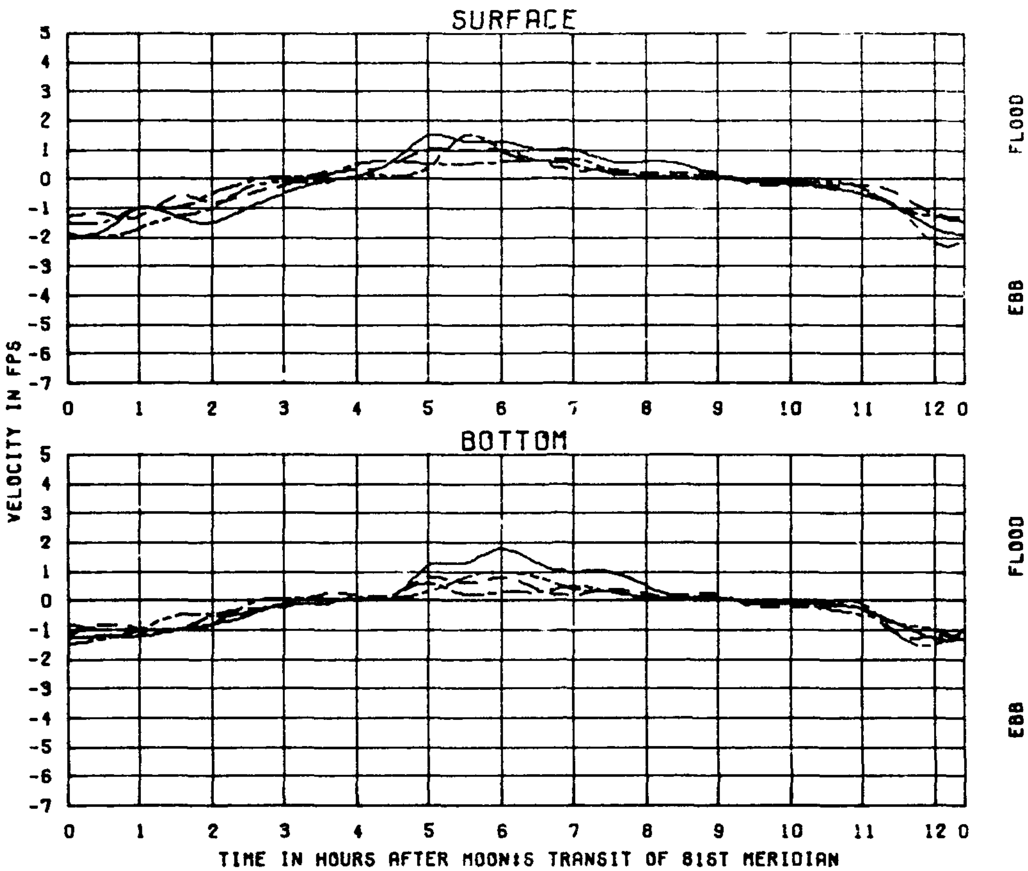
PLAN 9 —·—

PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1182



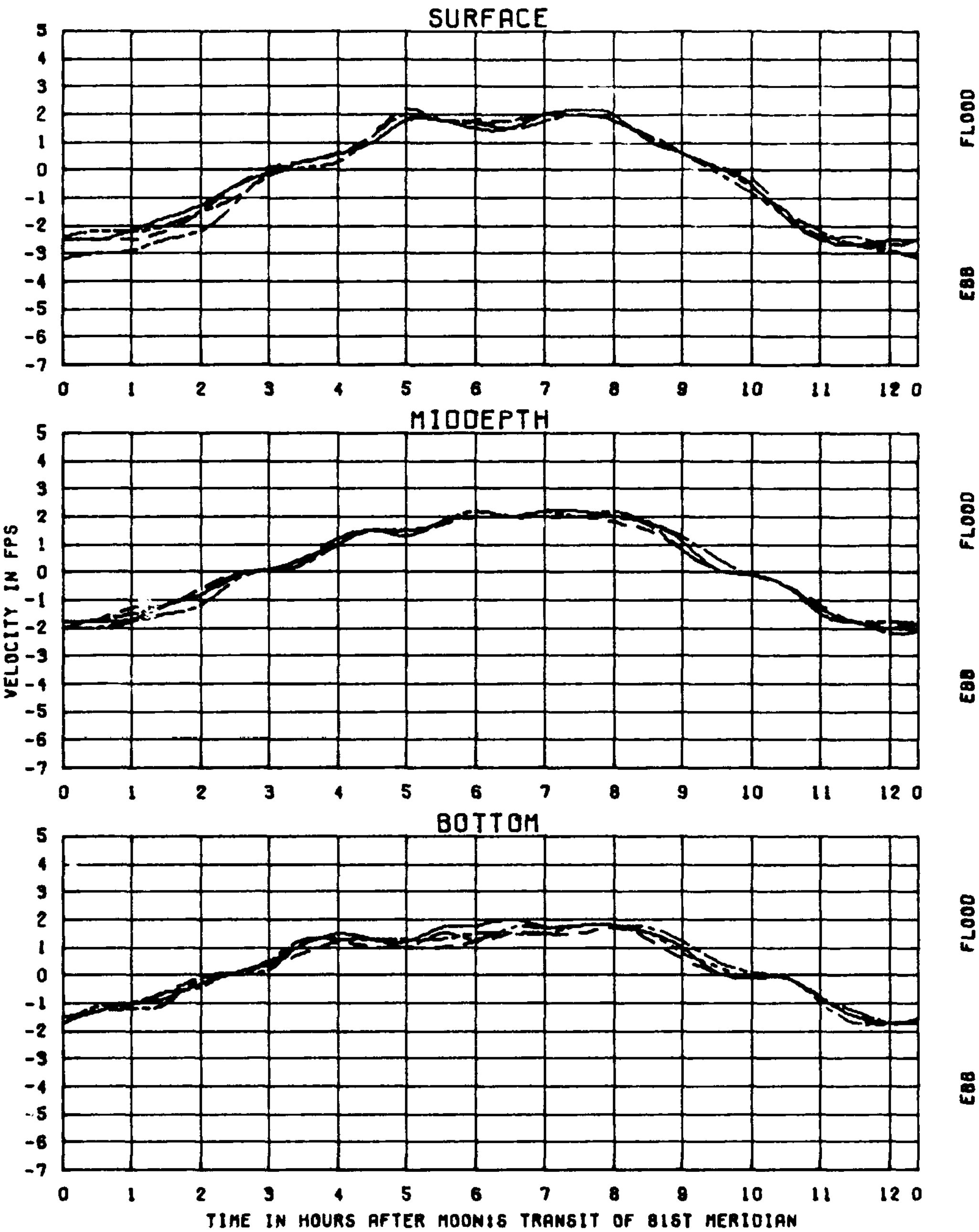
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-—
PLAN 10 —--—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
1276



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

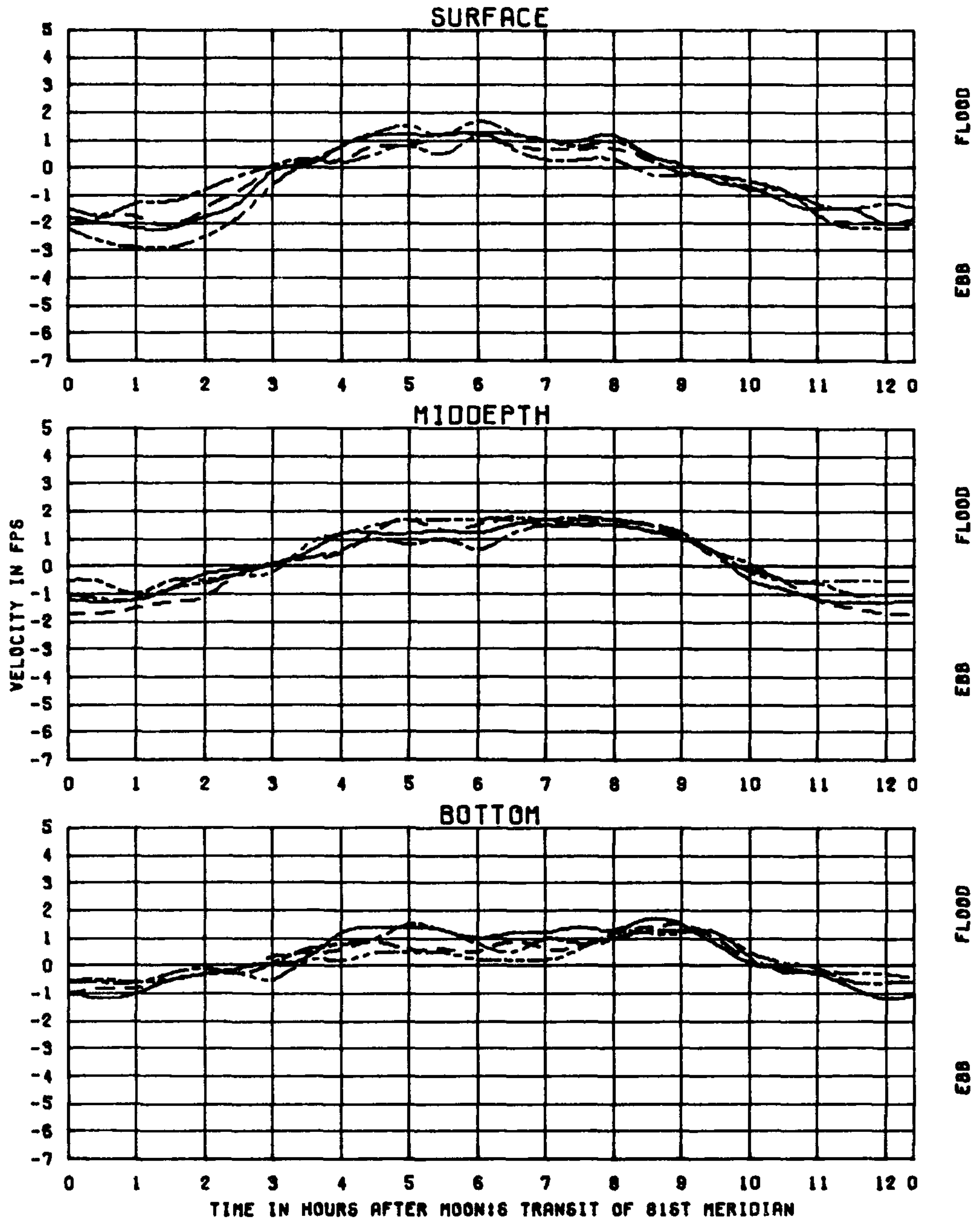
LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —·—·—
PLAN 10 -------

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION

1385



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

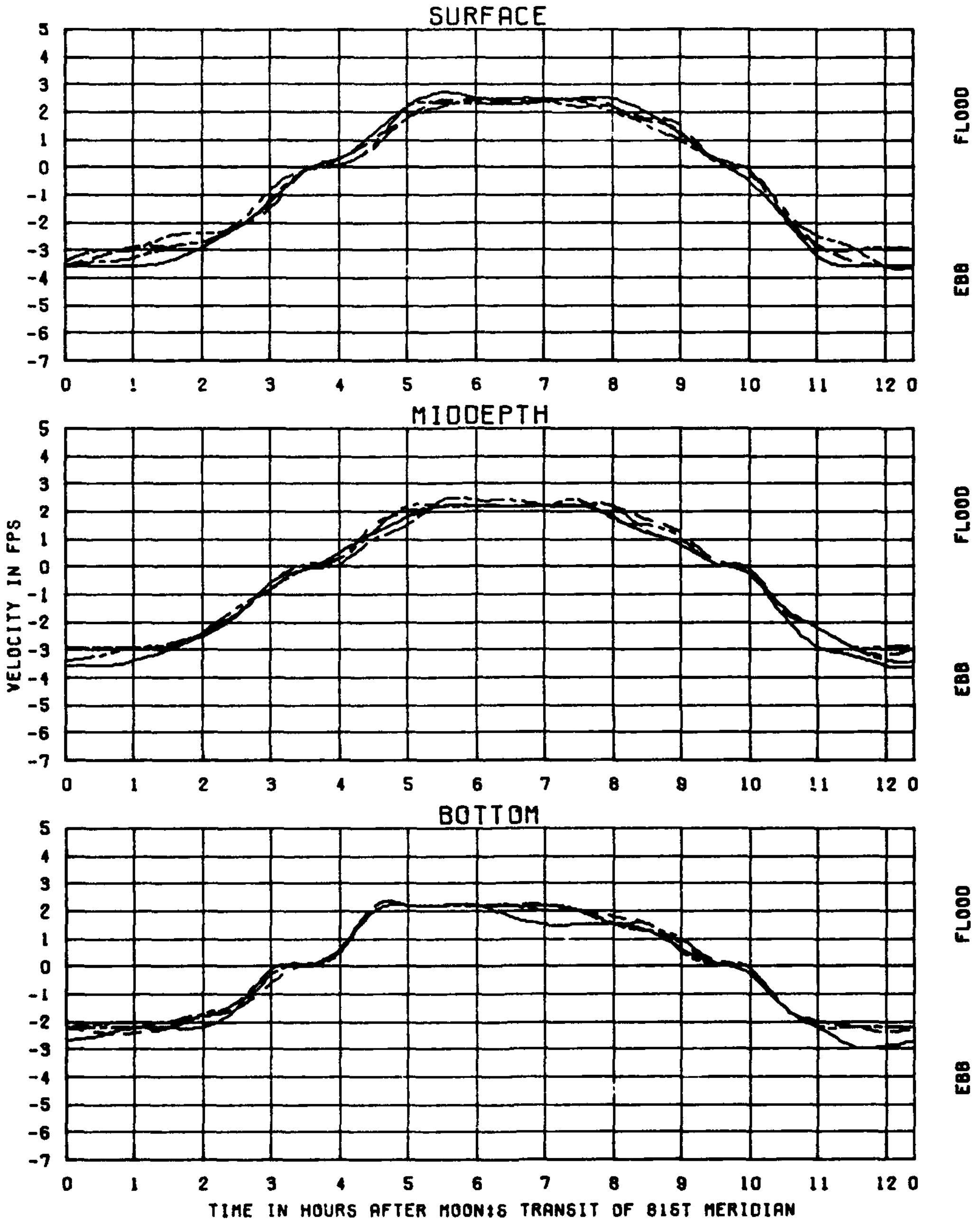
LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1851



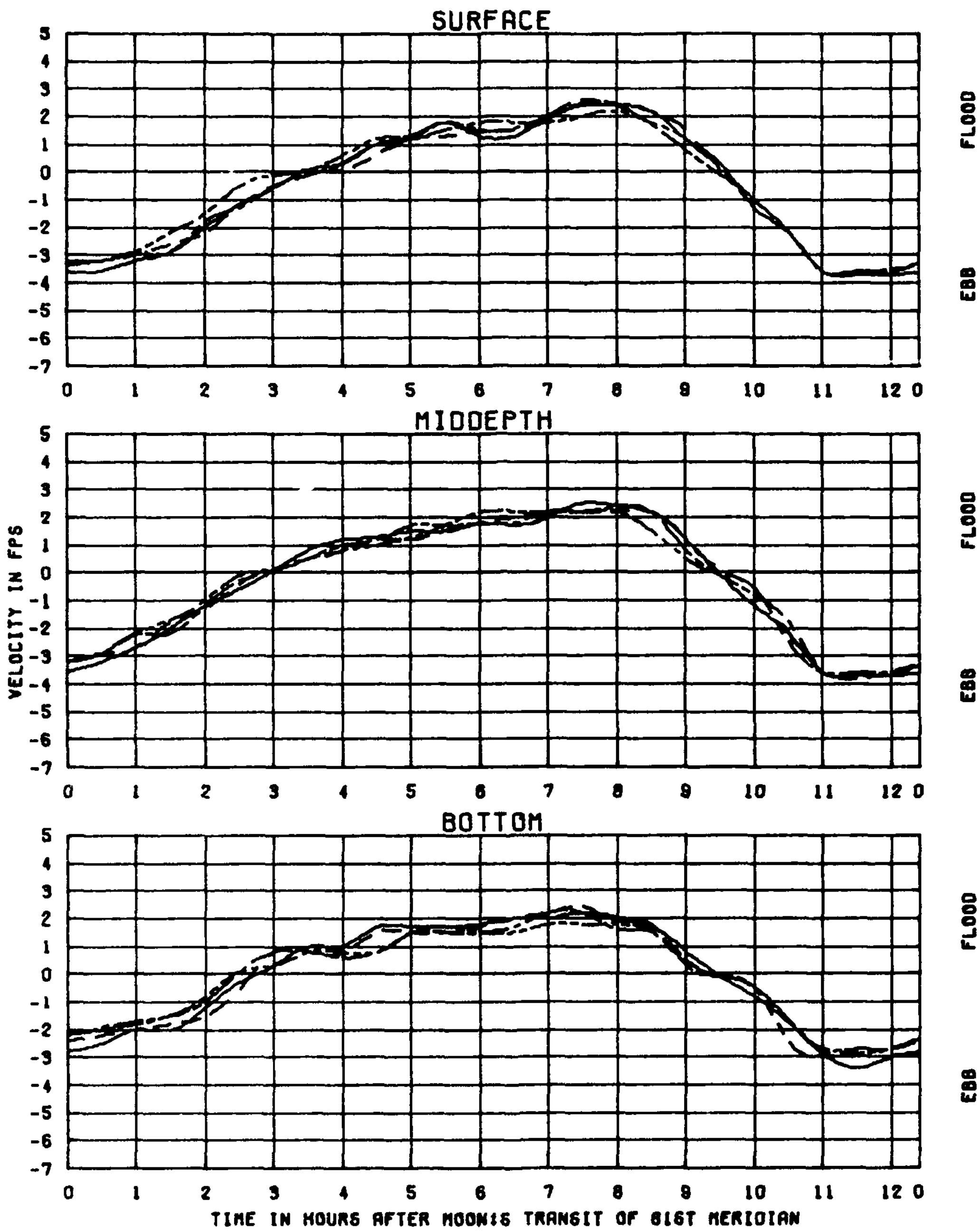
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
1865



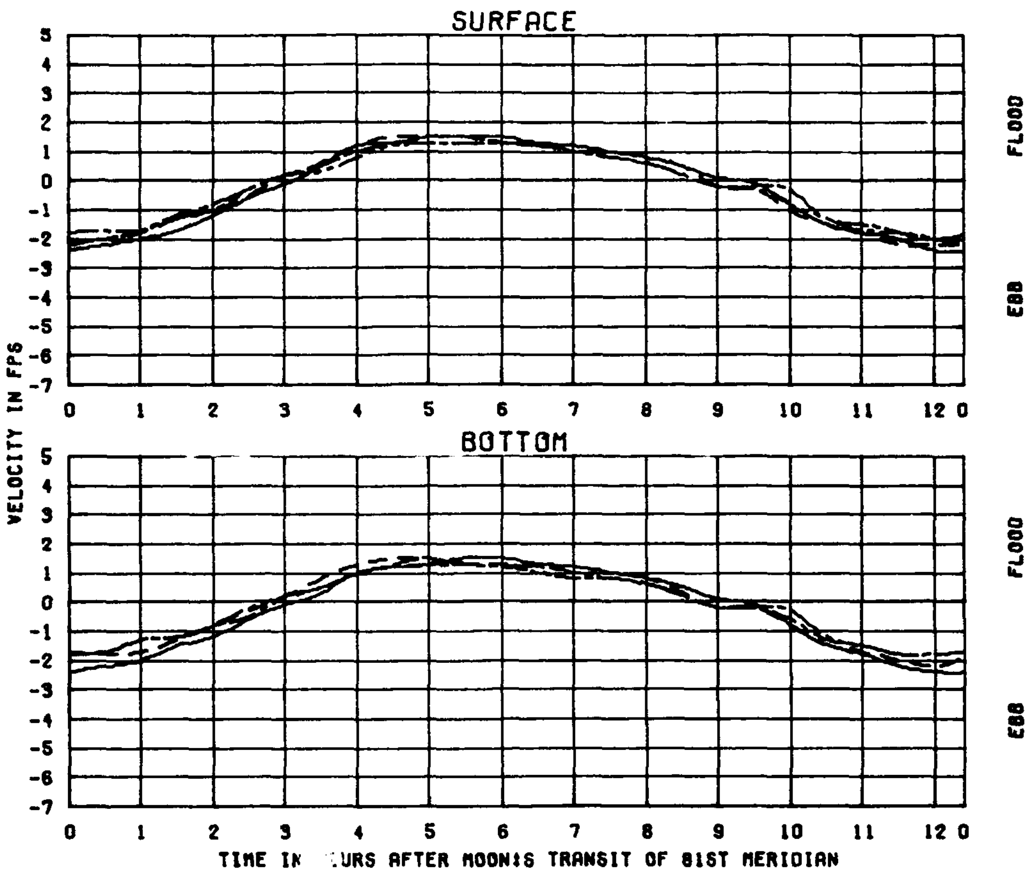
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----—

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
1869



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

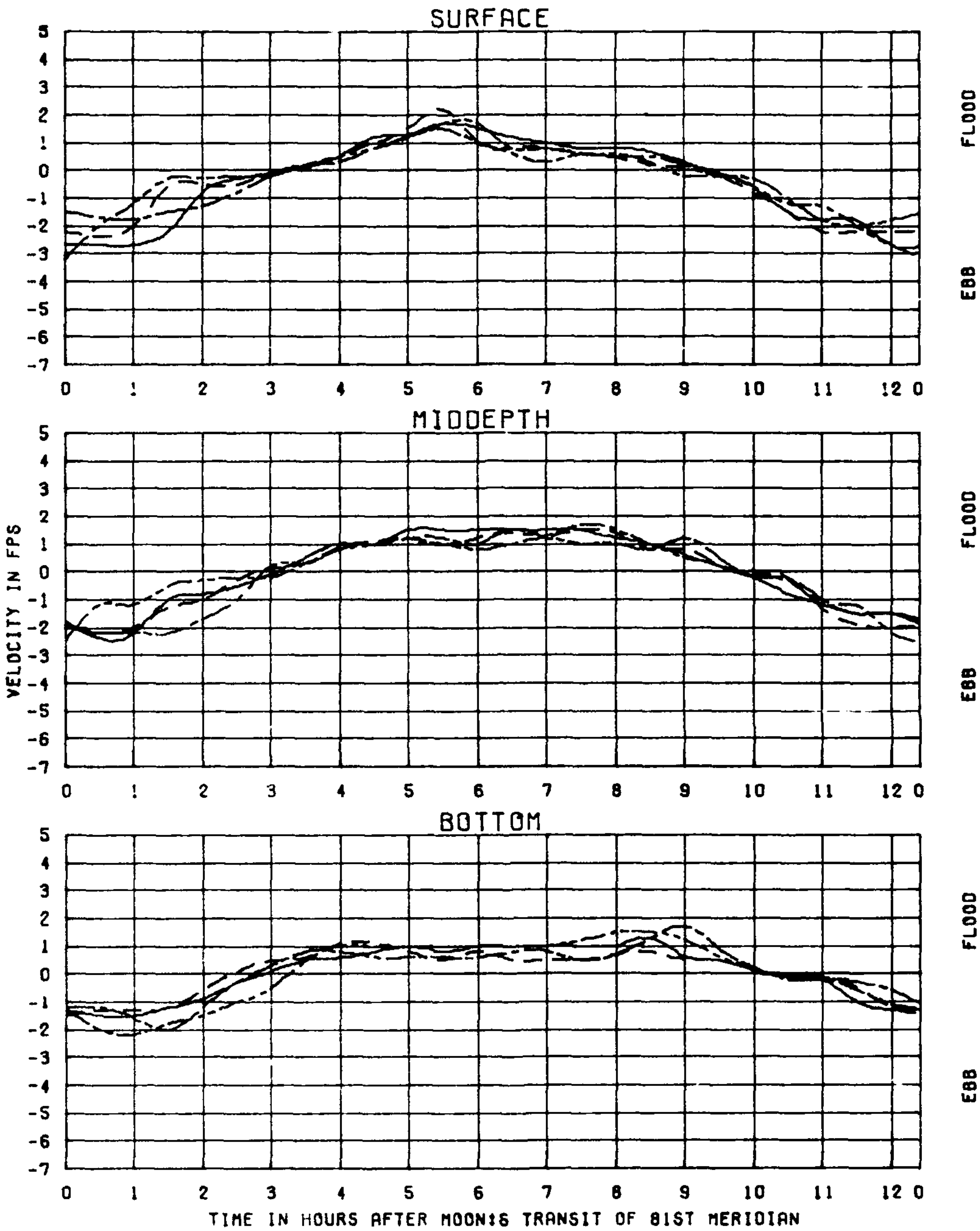
LEGEND

BASE	———
PLAN 8	— — —
PLAN 9	—·—
PLAN 10	----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
1883

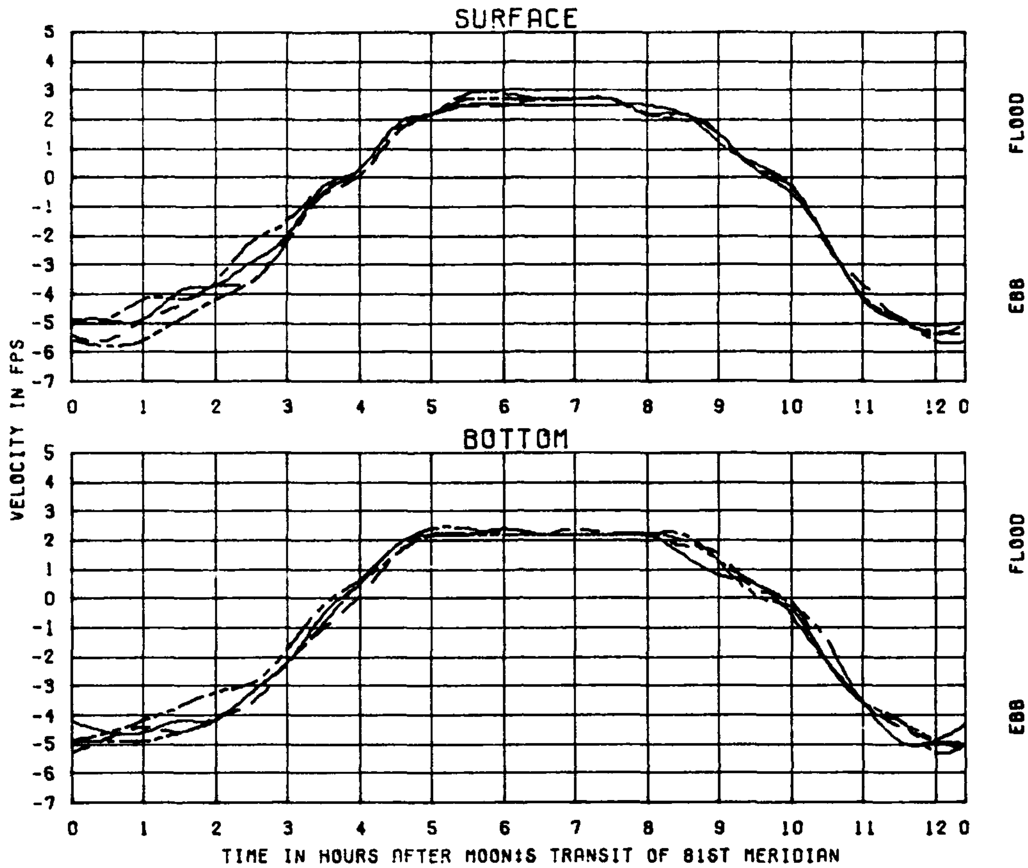


TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
1915

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —·—·—
PLAN 10 —··—··—



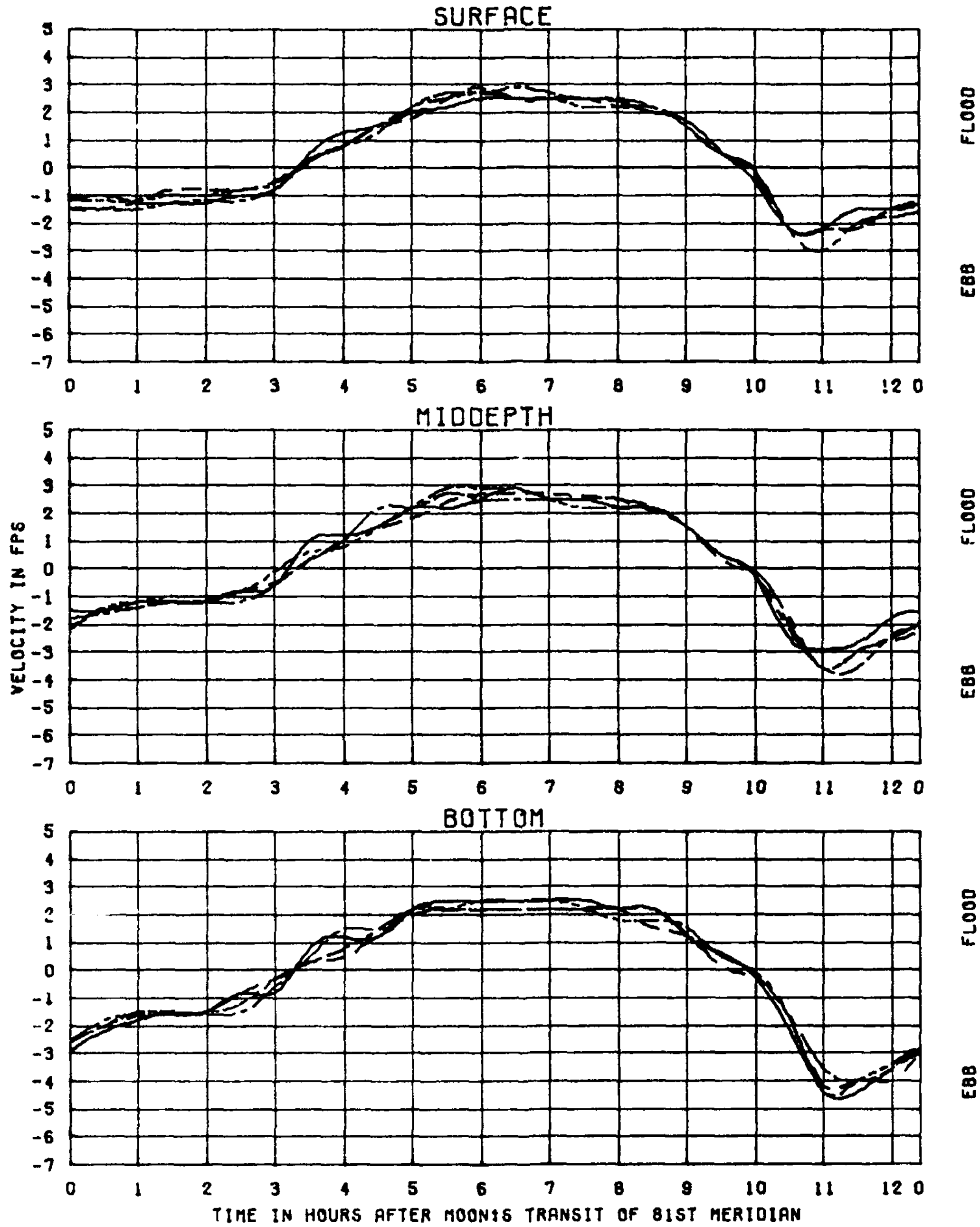
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-—
PLAN 10 -----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
1979



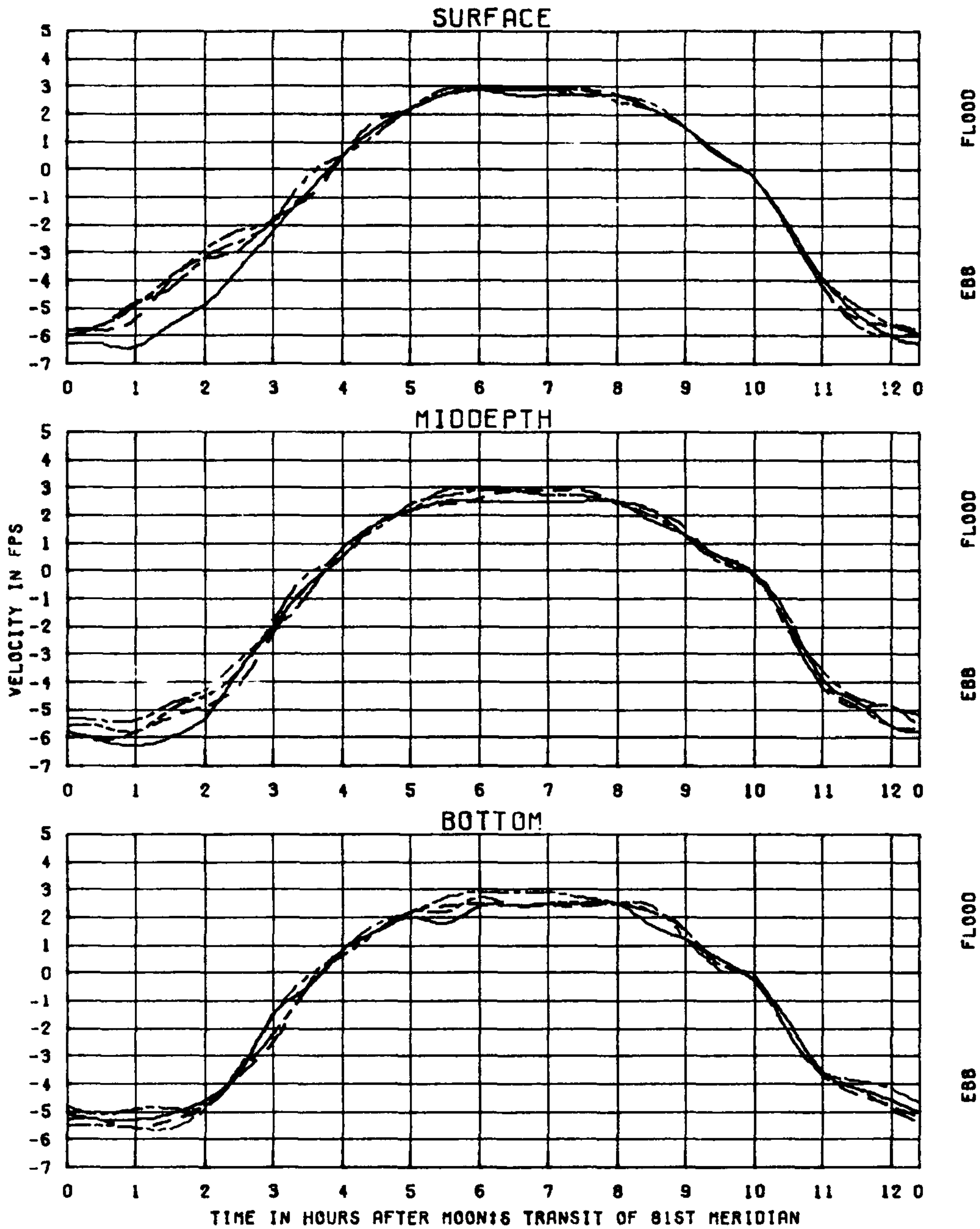
TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
1981

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-—-—
PLAN 10 -------



TEST CONDITIONS	
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

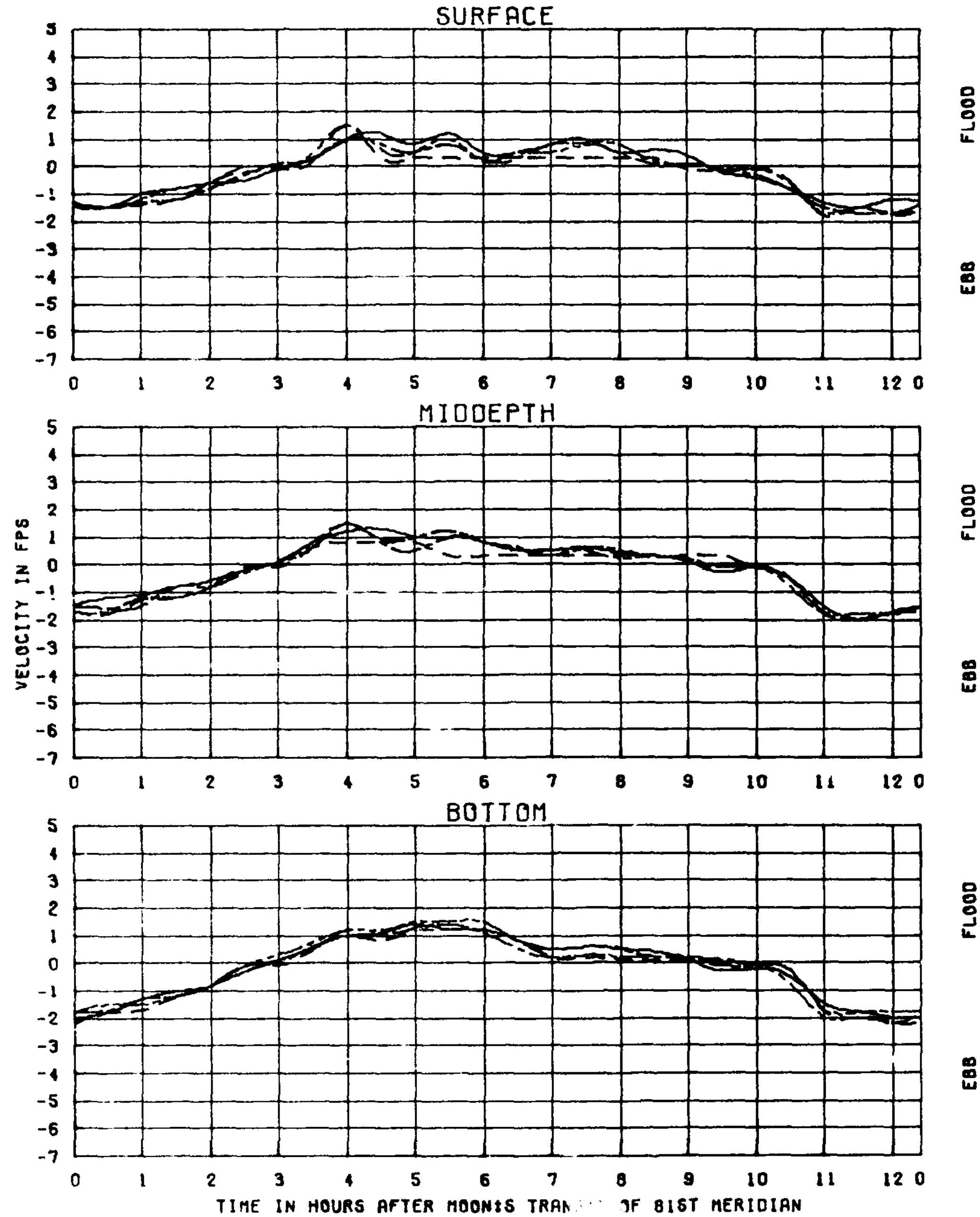
LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 -----

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1989



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

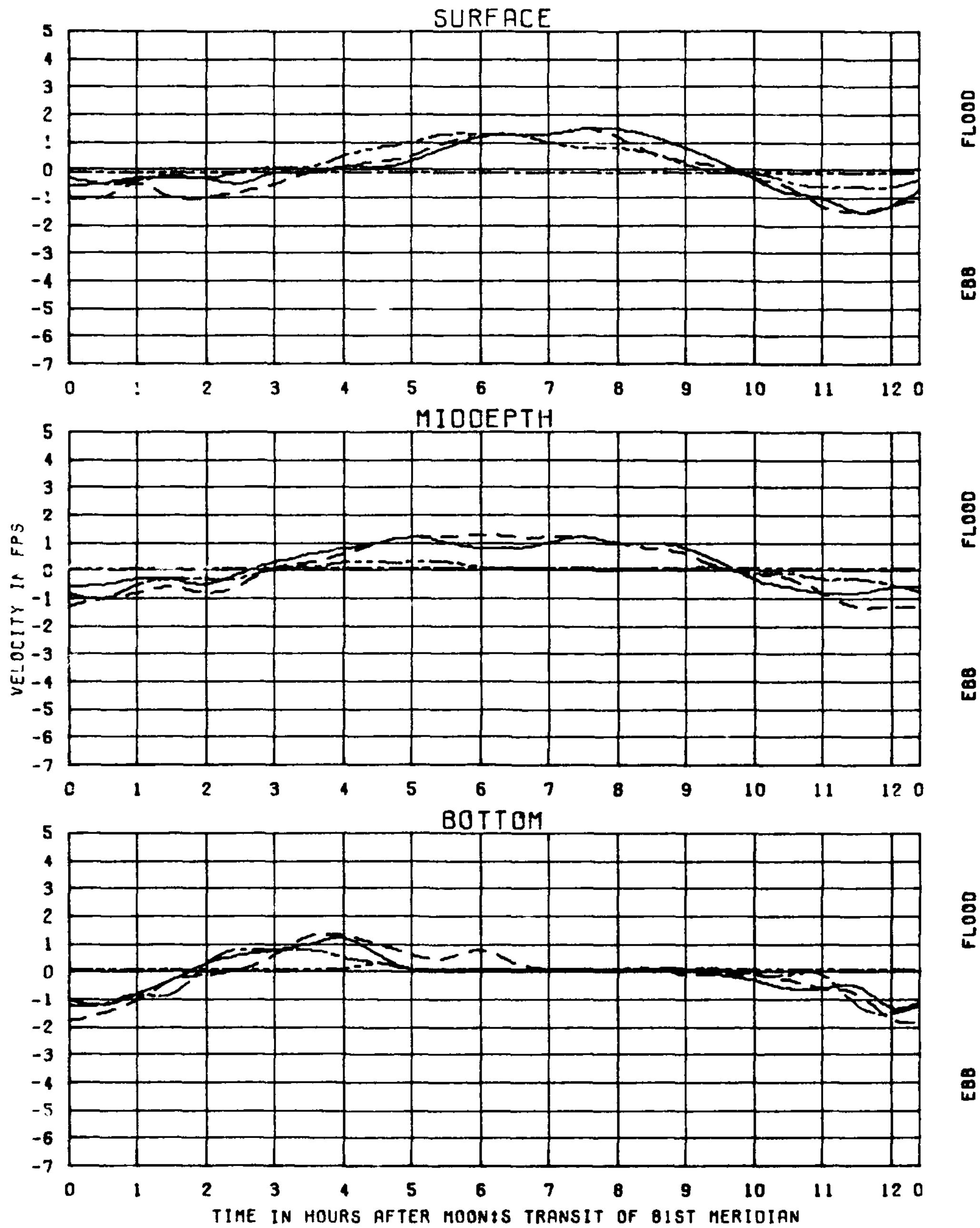
LEGEND

BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ------

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 1999



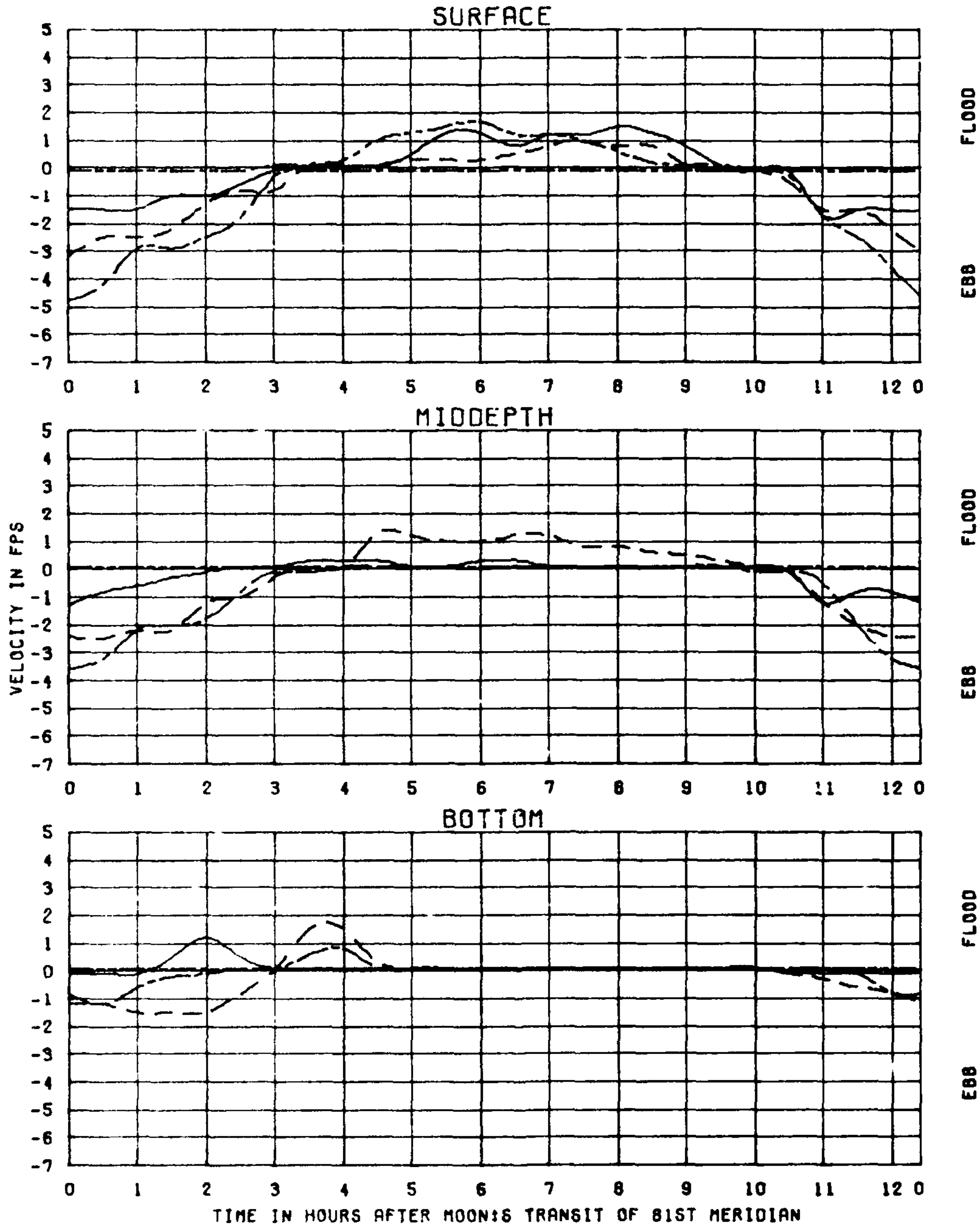
TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 - - - -

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
2074



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY (TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

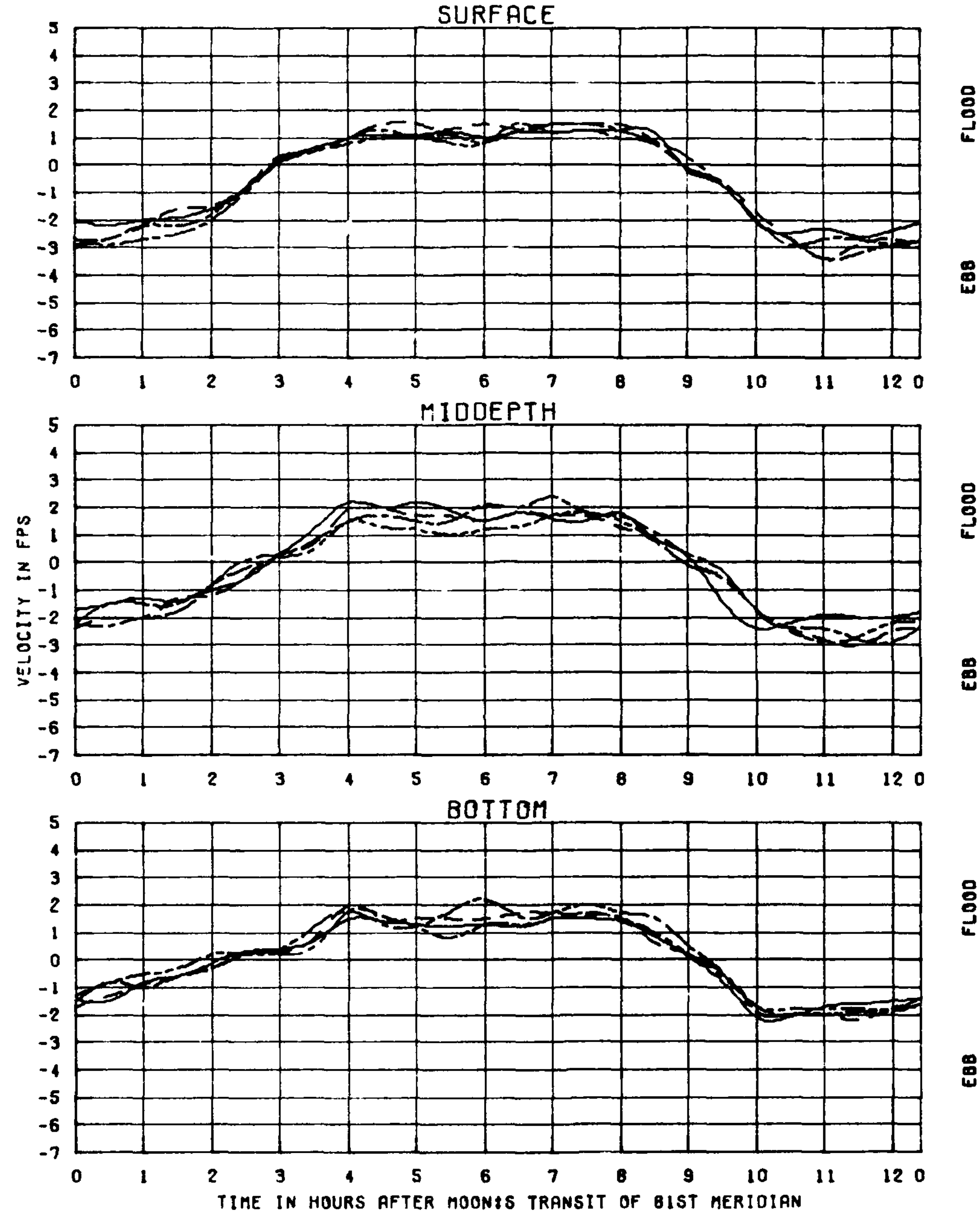
LEGEND

BASE ————
PLAN 8 — — —
PLAN 9 —·—
PLAN 10 ----

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES

STATION
2089



TEST CONDITIONS

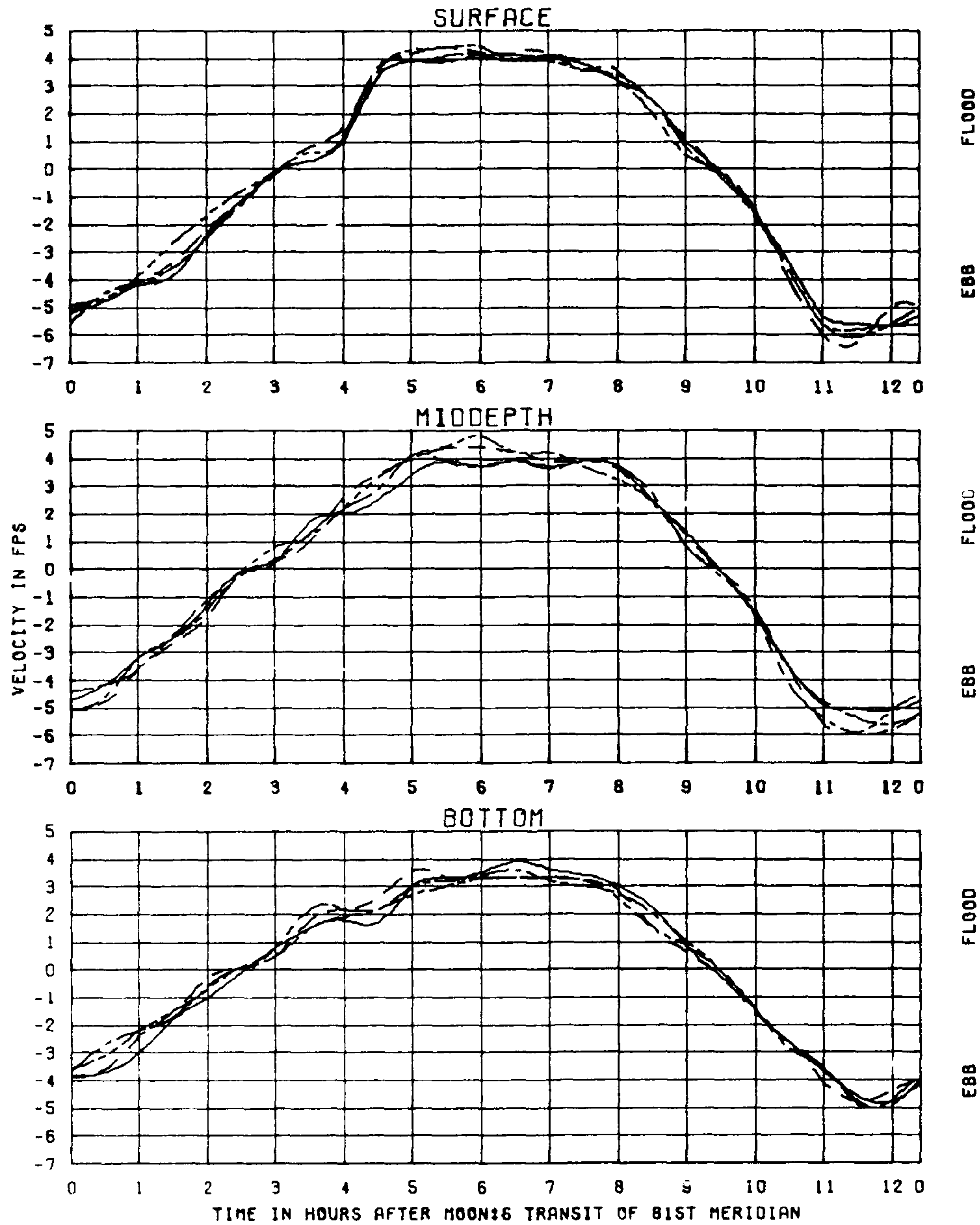
TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —·—·—
PLAN 10 —··—

KINGS BAY MODEL

EFFECTS OF PLANS P4-8,P4-9,AND P4-10 ON VELOCITIES

STATION 2120



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

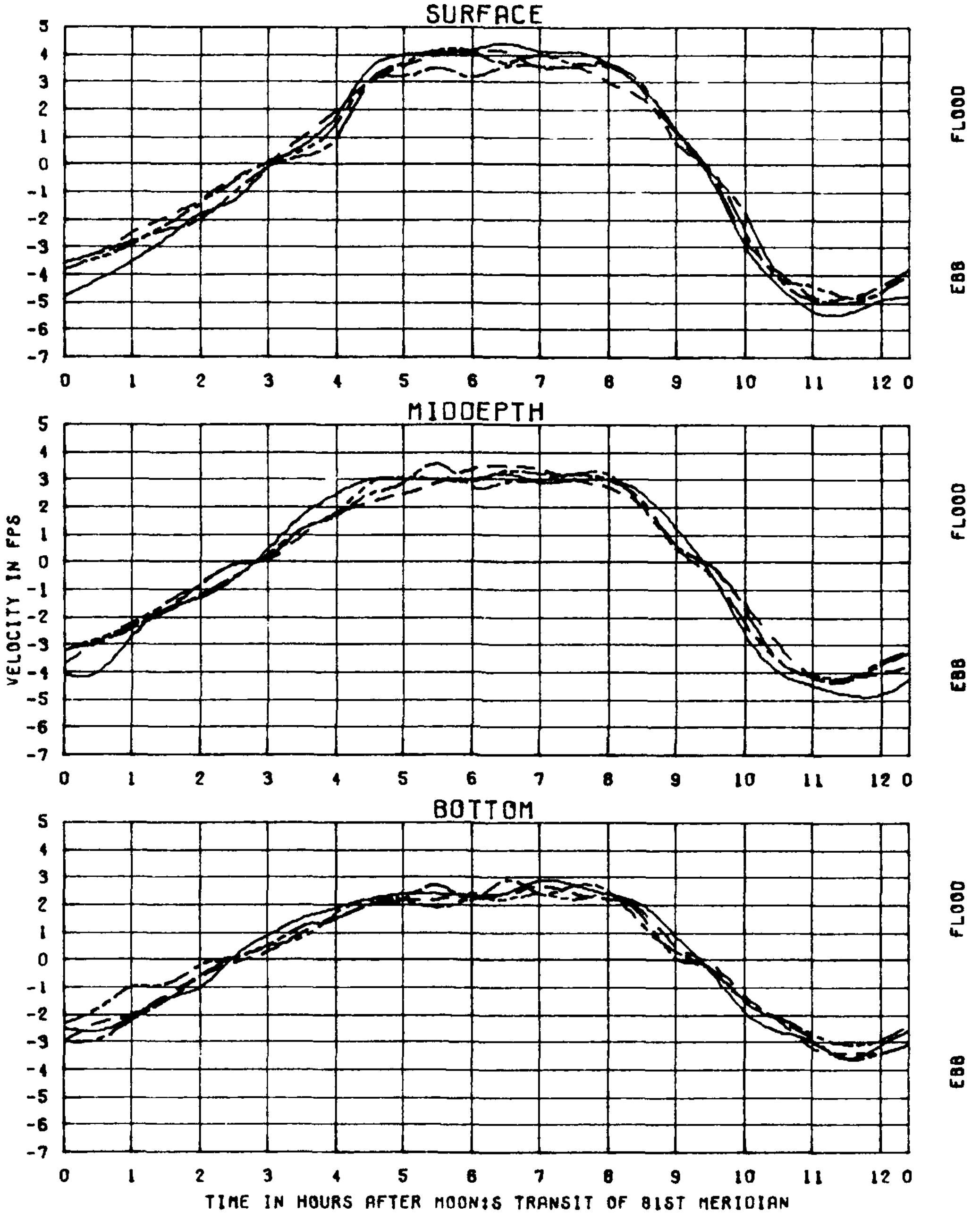
LEGEND

BASE ————
PLAN 8 — — —
PLAN 9 —·—·—
PLAN 10 - - - - -

KINGS BAY MODEL

EFFECTS OF PLANS P4-8, P4-9, AND P4-10 ON VELOCITIES

STATION 2122



TEST CONDITIONS

TIDE RANGE AT GAGE 1	5.8 FT
OCEAN SALINITY(TOTAL SALT)	32.5 PPT
FRESHWATER INFLOW	1100 CFS

KINGS BAY MODEL

EFFECTS OF PLANS
P4-8, P4-9, AND P4-10
ON VELOCITIES
STATION
2124

LEGEND
BASE ———
PLAN 8 — — —
PLAN 9 —-—-
PLAN 10 ------

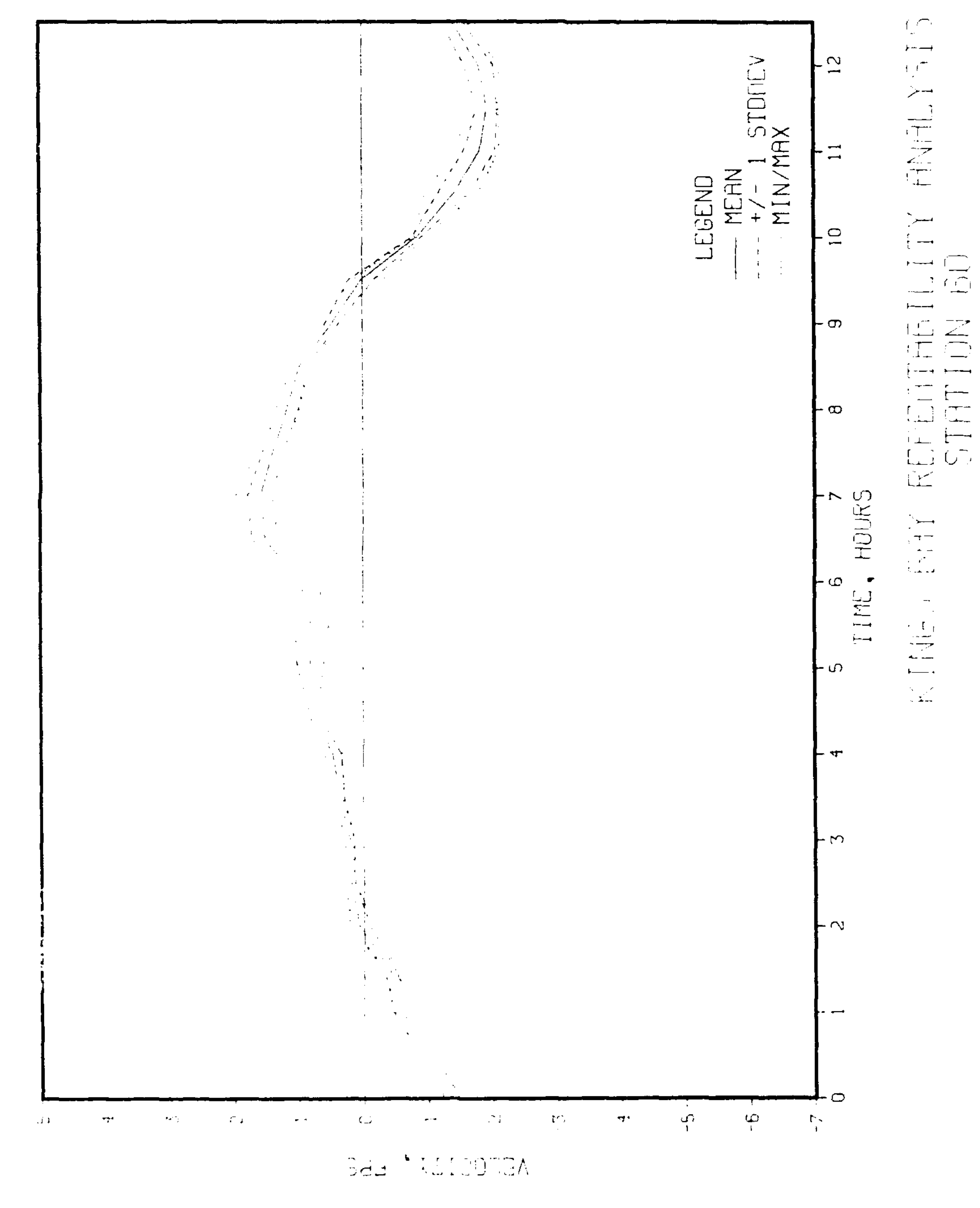
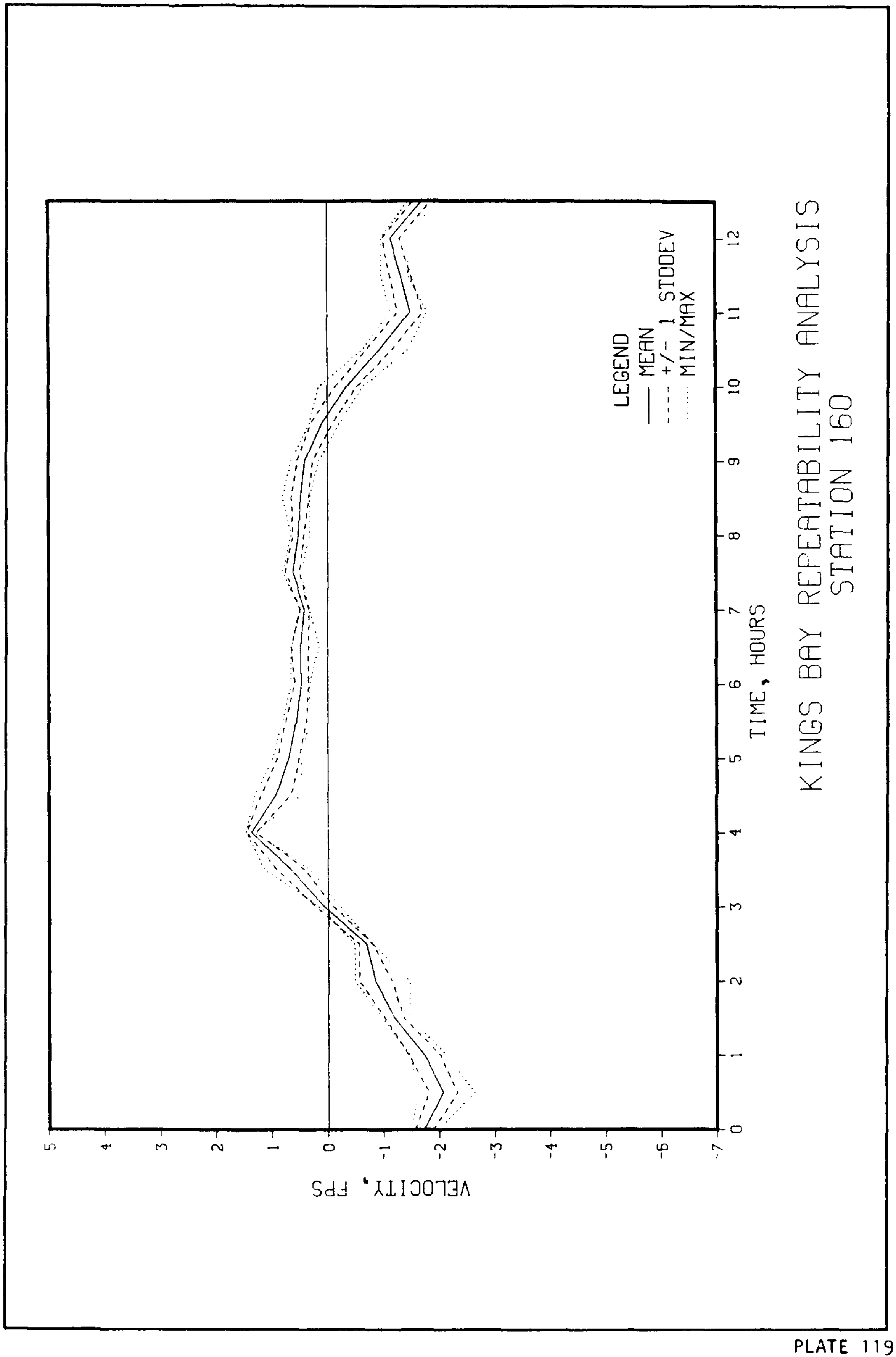
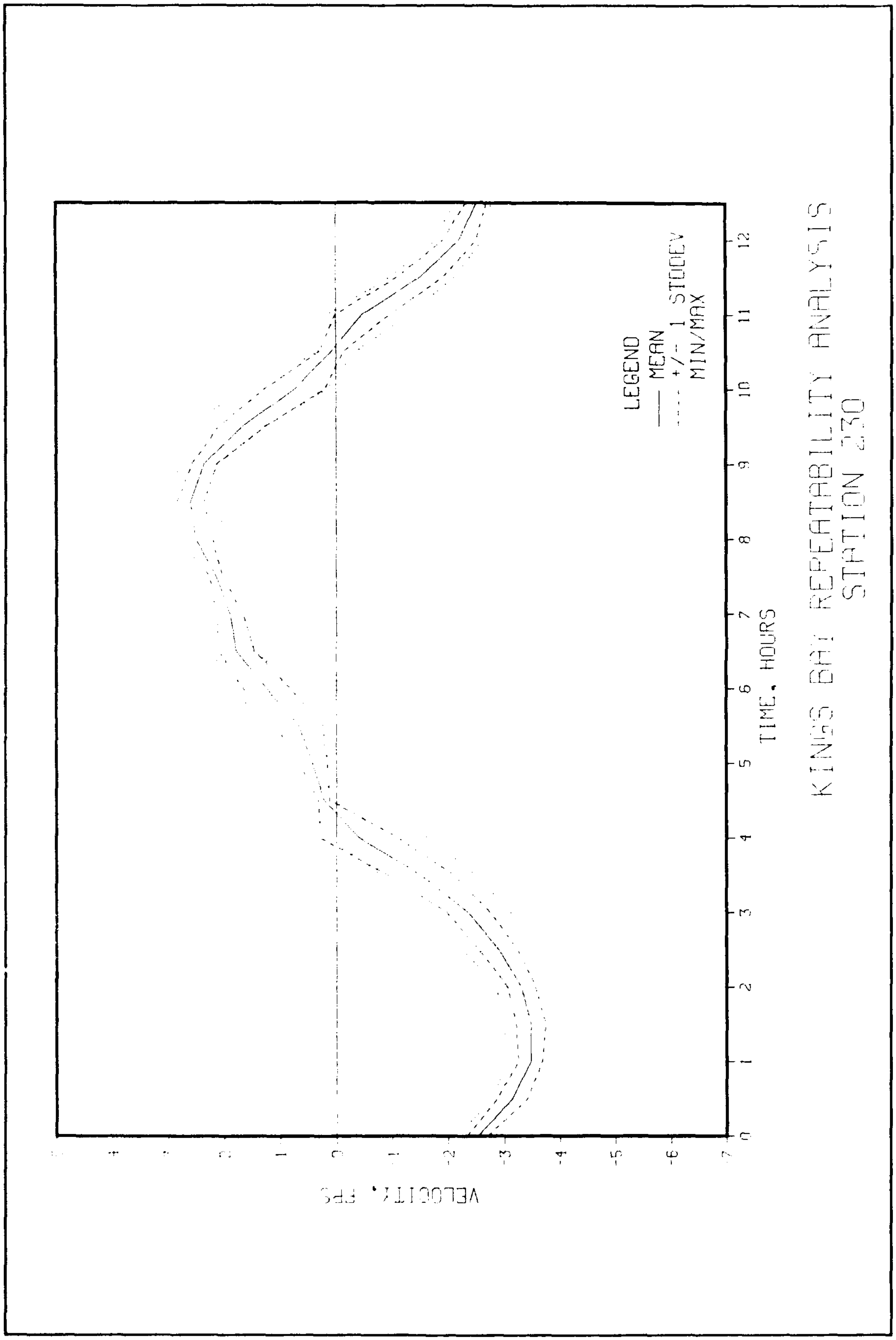
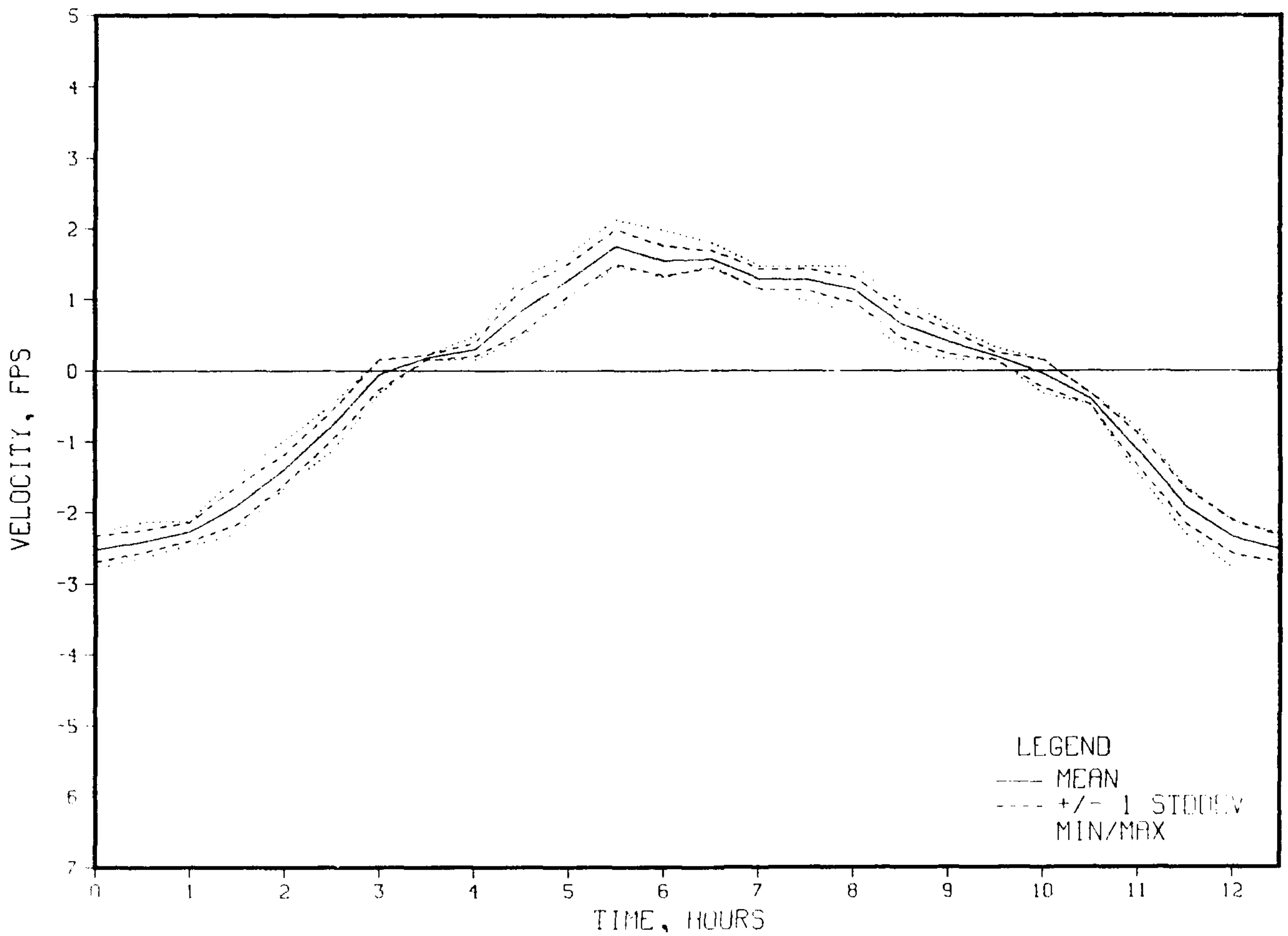

KINGS BAY REPEATABILITY ANALYSIS
STATION 6D
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS

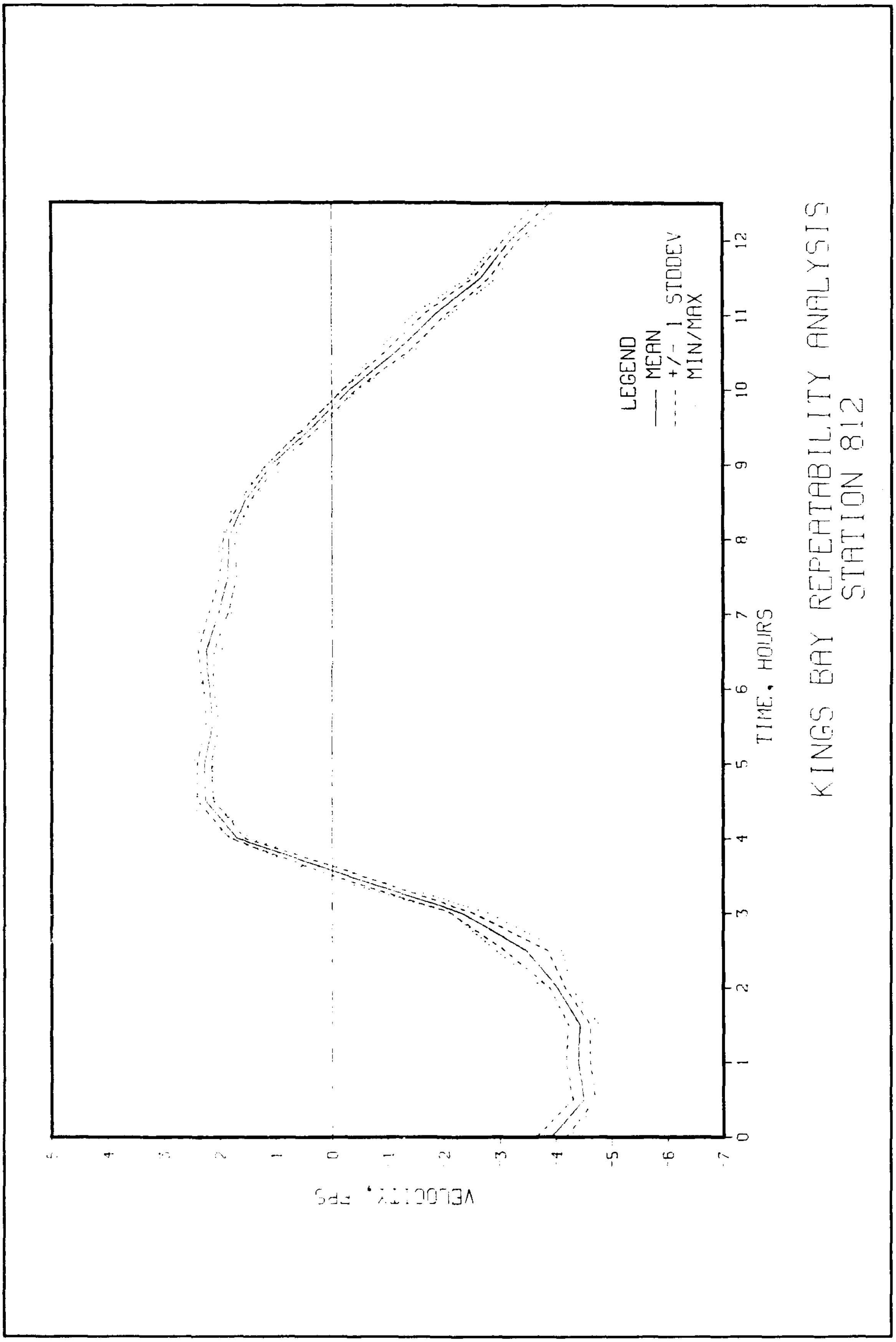
PLATE 118


KINGS BAY REPEATABILITY ANALYSIS
STATION 160
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
0
1
2
3
4
5
6
7
8
9
10
11
12
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7


KINGS BAY REPEATABILITY ANALYSIS
STATION 230
TIME, HOURS
VELOCITY, FPS
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX

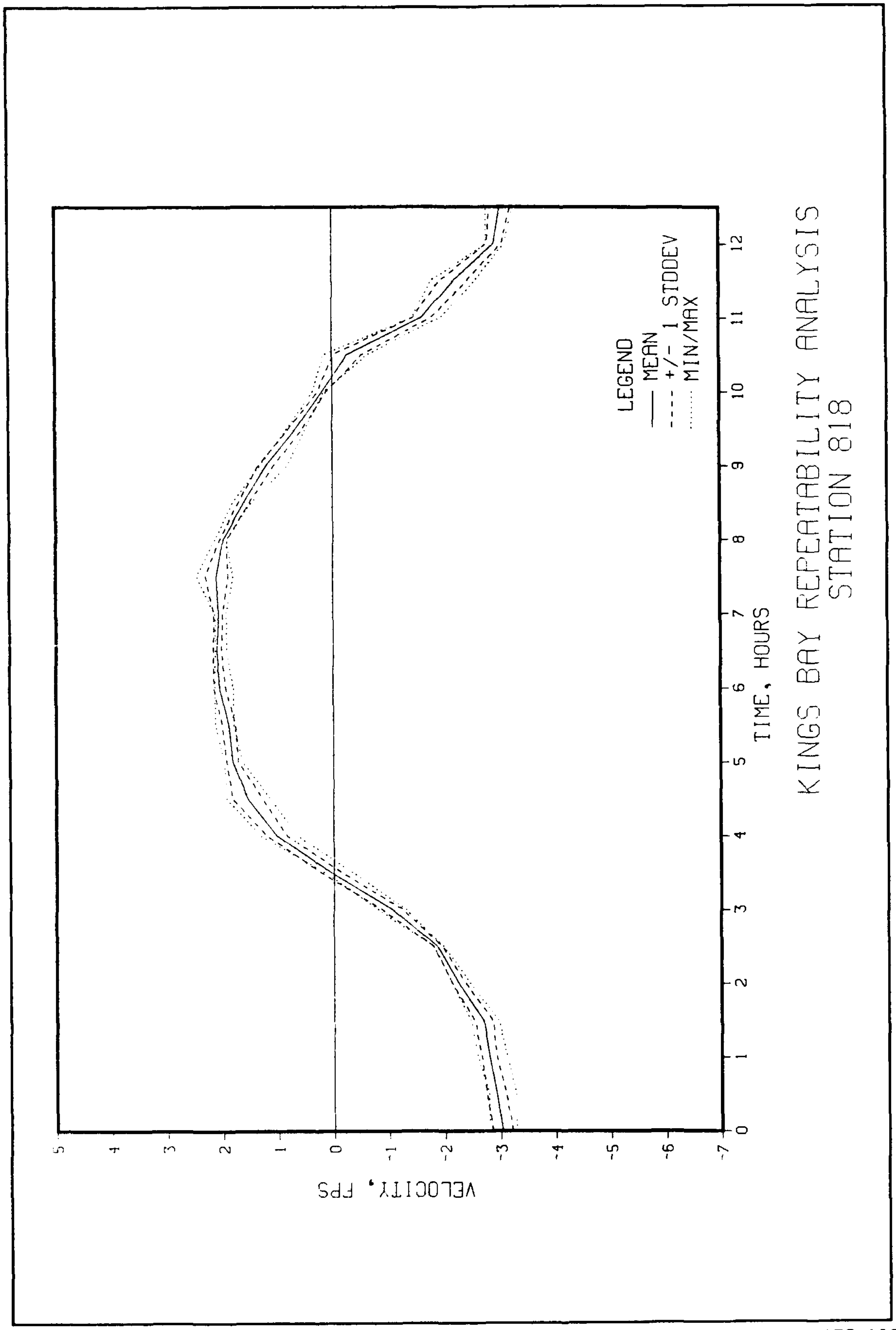


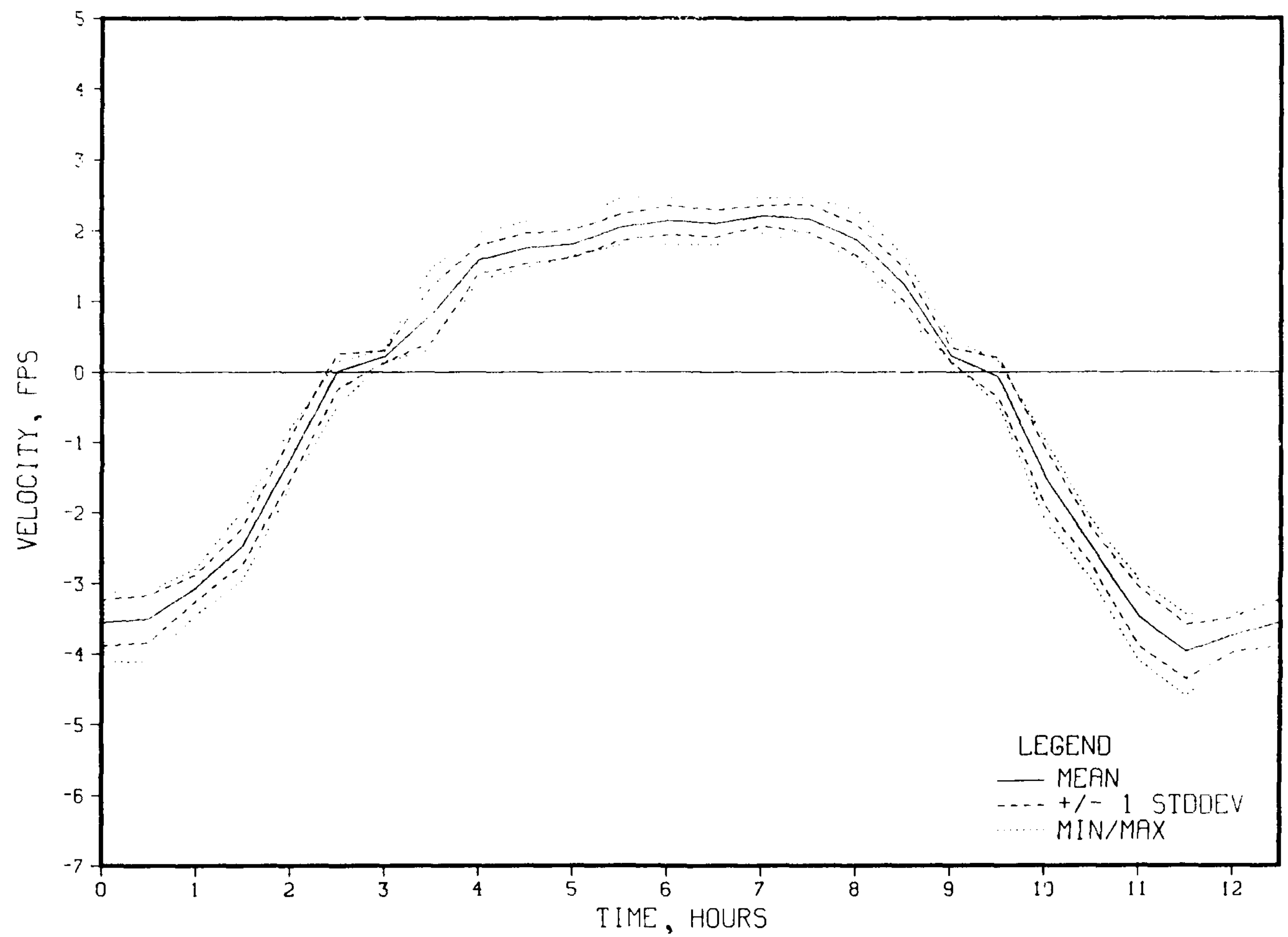
KINGS BAY RCPEATABILITY ANALYSIS
STATION 650



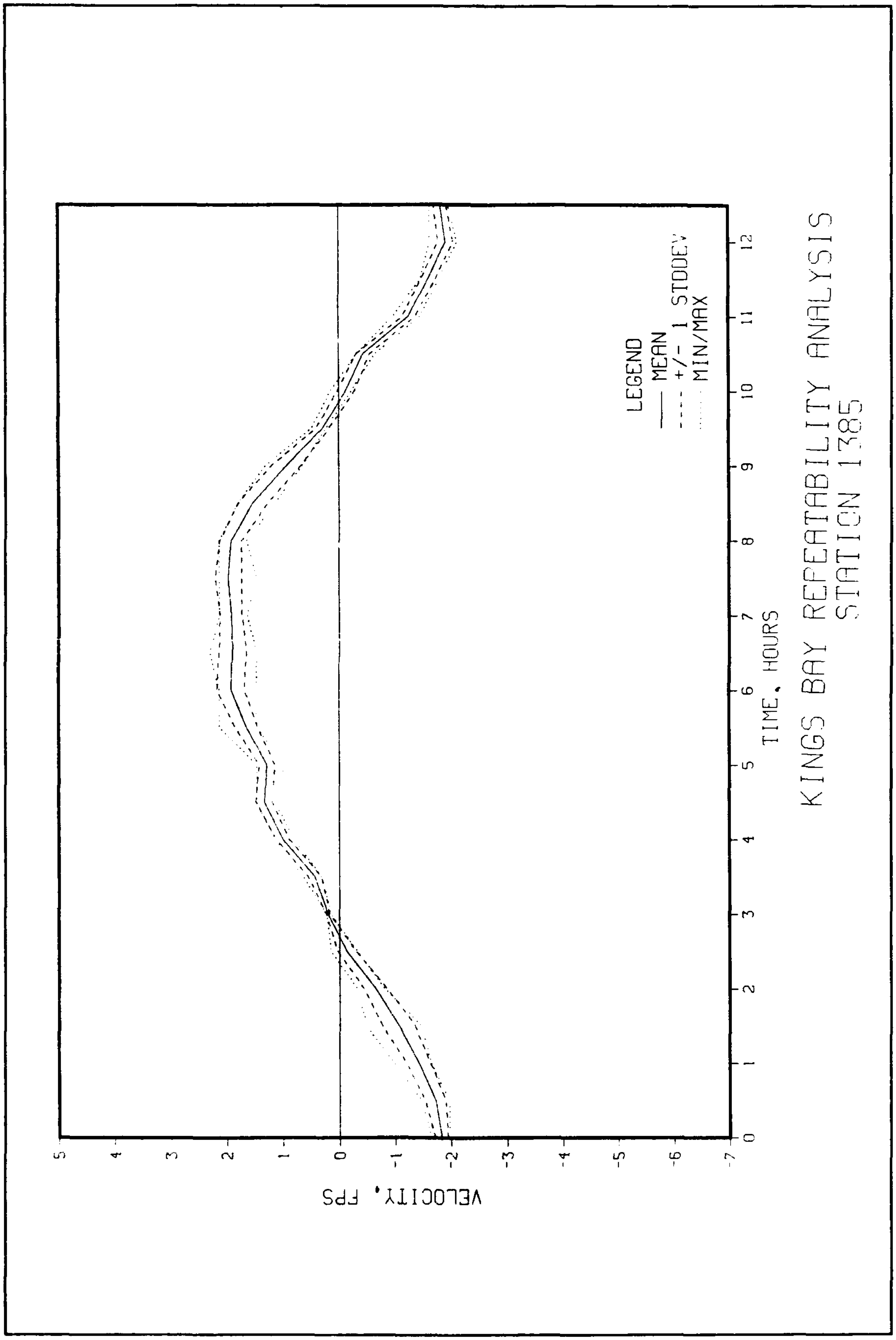
KINGS BAY REPEATABILITY ANALYSIS
STATION 812
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS

PLATE 122


KINGS BAY REPEATABILITY ANALYSIS
STATION 818
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
0
1
2
3
4
5
6
7
8
9
10
11
12
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7



KINGS BAY REPEATABILITY ANALYSIS
STATION 843



KINGS BAY REPEATABILITY ANALYSIS
STATION 1385
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
0
1
2
3
4
5
6
7
8
9
10
11
12
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

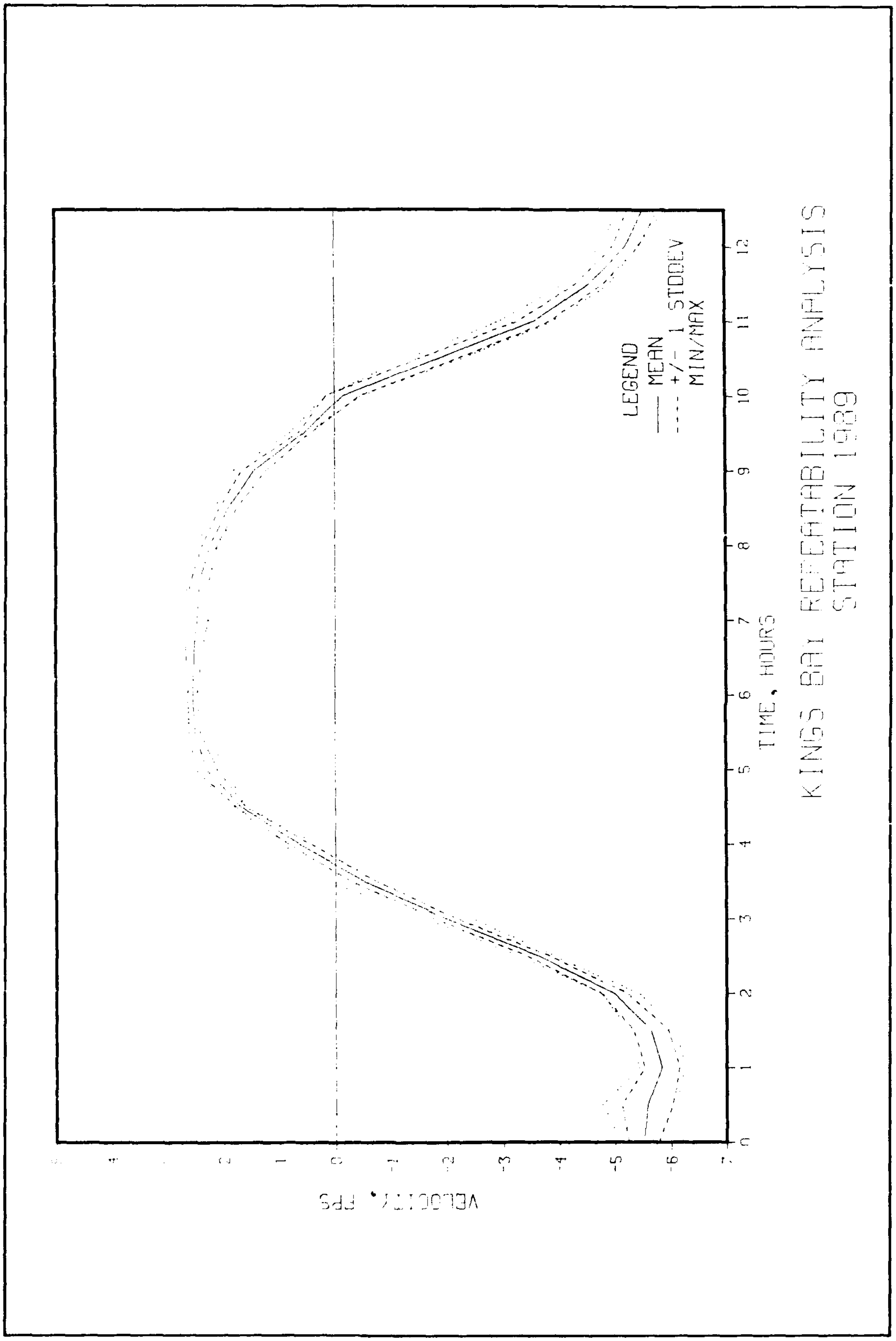
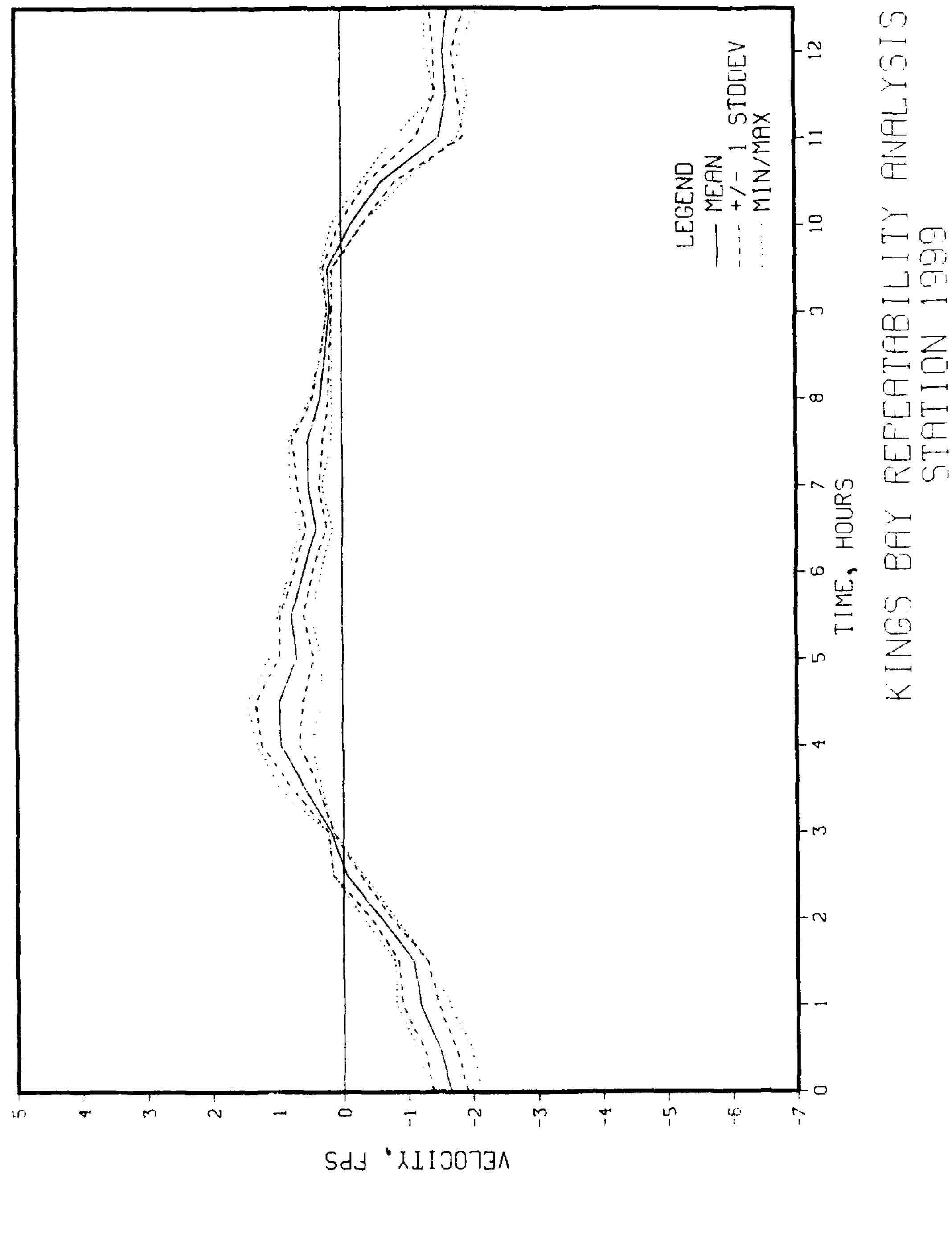

LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
KINGS BAY REPEATABILITY ANALYSIS
STATION 1989

PLATE 126


KINGS BAY REPEATABILITY ANALYSIS
STATION 1999
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
0
1
2
3
4
5
6
7
8
9
10
11
12
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

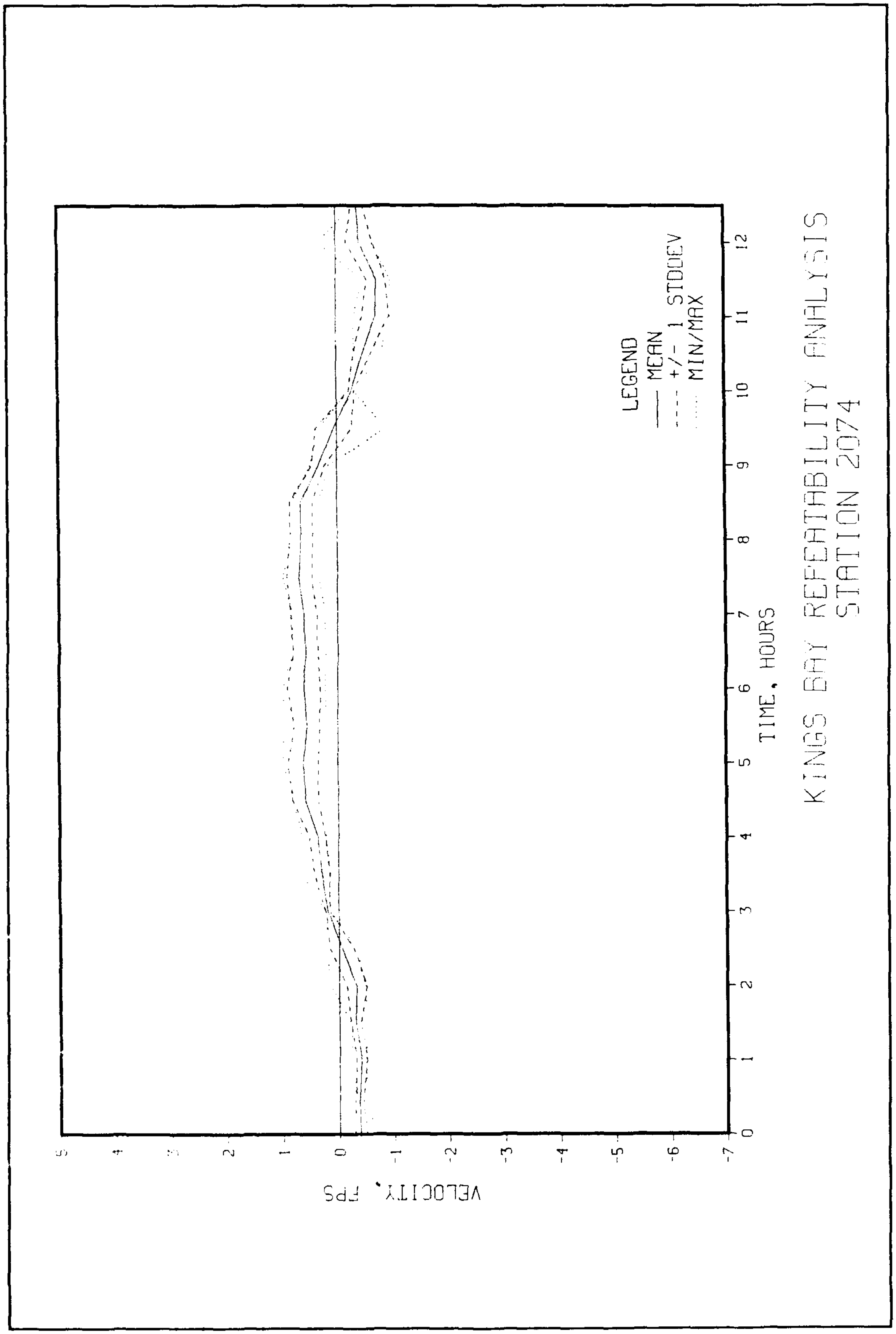
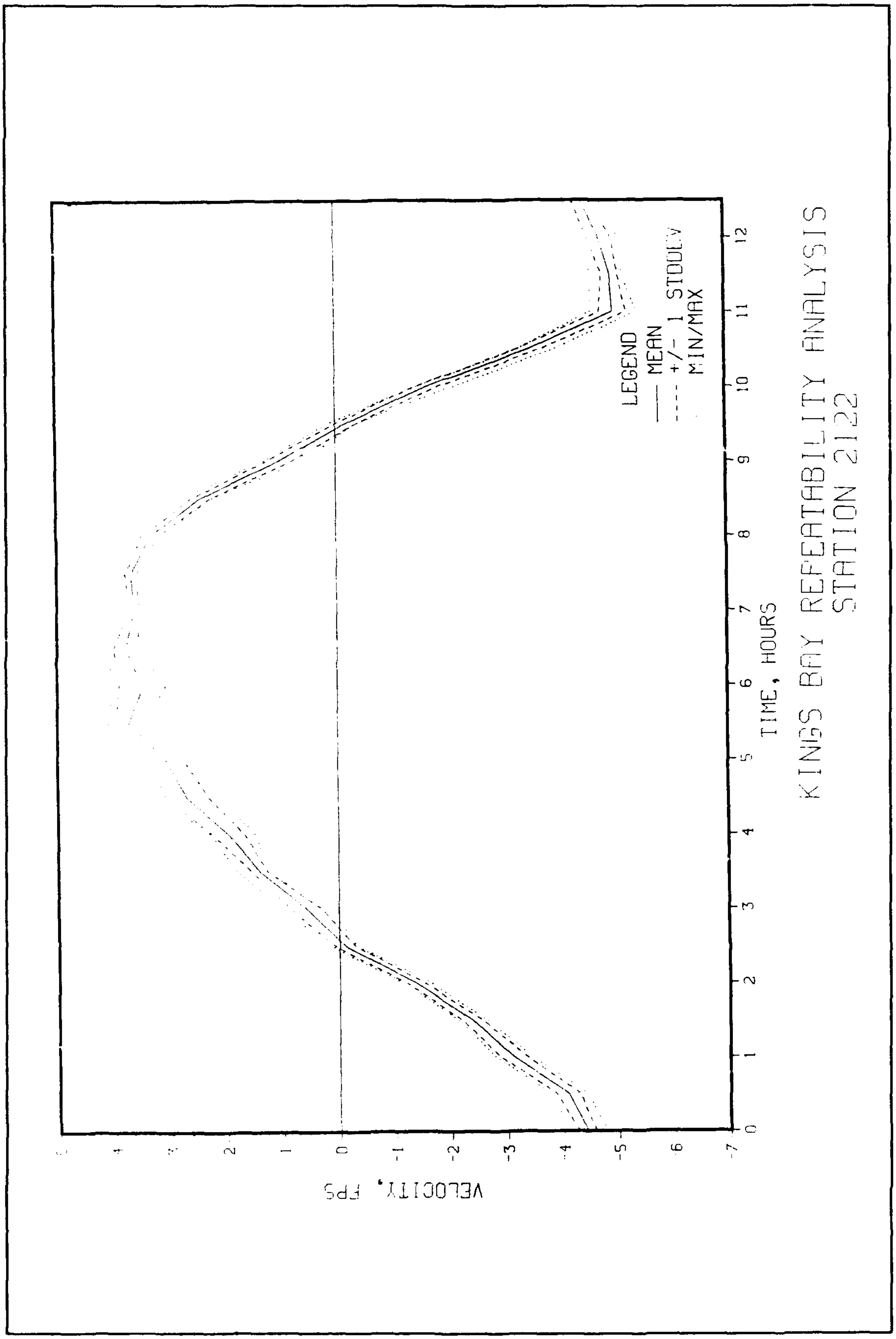

KINGS BAY REPEATABILITY ANALYSIS
STATION 2074
LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
0 1 2 3 4 5 6 7 8 9 10 11 12
5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7

PLATE 128


LEGEND
MEAN
+/- 1 STDDEV
MIN/MAX
TIME, HOURS
VELOCITY, FPS
KINGS BAY REPEATABILITY ANALYSIS
STATION 2122